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THE

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FUTURE DEVELOPMENTS IN ELECTRIC RAILWAY TRACTION.

IT is curious to observe how successive waves of progress have passed, and continue to pass, over the electrical industry. First came the development of electric telegraphy, which, by attracting attention to the possibilities of electrical science, really laid the foundation of all subsequent advances. Next, the science of telegraphy being firmly established, electric lighting and power came to the front, and, for a time, practically monopolised the activities of electricians. Electric traction followed, and now bids fair to become by far the most prominent individual branch of electrical industry, though the rapidly-growing importance of electro-chemistry and electro-metallurgy may soon render these subjects, which, like all the others, date from the beginning of the last century, commercially pre-eminent.

Again, each branch of the industry is subject to minor waves of its own; thus, in electric traction, there have been waves of trolley systems, of underground conduits, of storage battery traction, of tube railways, and so on. But not one of these is comparable in magnitude with the enormous waves which appear to be at hand—the electrification of, first, suburban, and afterwards, main line, railways. The former, indeed, is upon us already; the latter, which raises very different problems, appears likely to attain to practical importance at no distant date.

It seemed as if the methods in vogue up till now for the electrical operation of suburban railways were likely to endure, quite irrespective of the means that might be adopted in the future for the conversion of main lines to electrical traction; that is to say, that direct current at voltages of 600 or 700, conveyed to the trains by means of conductor rails, would continue to be alone employed for this purpose. But the advent of the successful single-phase alternating current motor has brought this matter once more into the field of discussion. Will the direct current system be able to compete with the alternating under the new conditions, even for suburban railway working?

So long as the direct-current motor was the only practicable motor for the purpose—for which it was, moreover, so extremely well-fitted—the third rail, and possibly the fourth, was a necessary evil; for the direct-current motor did not admit of pressures very much higher than those in use at present, and the trolley wire was totally unfitted for supplying the large currents called for by high accelerations and heavy loads. The third rail being thus compulsory, the pressure could not even be raised to the maximum for which the D.C. motor could be made, owing to the danger thereby entailed to human life and limb—a danger not by any means absent under existing conditions, but quite

intolerable at pressures of 1,000 volts or more. With the use of alternating current, however, pressures of 10,000 volts and upwards on the working conductor become possible, at once allowing of the use of an overhead conductor, and compelling it to be placed out of reach.

Directly it becomes possible to use an overhead conductor of small dimensions, numerous difficulties inherent to the third-rail system at once disappear. Thus the trouble at crossings—witness the short circuits which have so frequently taken place at these points on existing third-rail systems—will be abolished; the trains will be fitted with sliding bow collectors instead of trolley wheels, and will run freely in either direction at junctions, without possibility of the trolley taking the wrong line and coming to grief. Again, the formation of frozen sleet on the working surface of the third rail, which has given so much trouble in America, will be avoided. Repairs to the permanent way can be carried on at all times without fear of contact with, or interruption of, live conductors. The track will be harmless to man and beast, and electrolytic troubles will not arise. There will be no difficulty in fixing the working conductor at a uniform height on all railways using the system, and there should be little difficulty in arranging for interchangeability of rolling stock. Experience on the Valtellina Railway shows that it will be possible to utilise the overhead conductor in tunnels—if this can be done with two conductors at 3,000 volts difference of potential, how much more easily with only one! As for the supply of power to the line, it is obvious that the simple transformation of alternating current is much more efficient and less expensive than the conversion of three-phase into direct current by means of running machinery, which entails the presence of attendants in the sub-stations; moreover, in most cases of suburban railways there would be no need of transformation at all, the current being supplied direct to the working conductor at high pressure. It must be admitted that transmission of power by single-phase current is less economical of copper than with three-phase current; this, however, in the case of heavily-worked suburban lines, is only apparently an objection, for the main transmission could still be three-phase, and the distribution two-phase—one phase to each track.

As for the inductive drop in the rails used as return circuit, taking account of the high pressure of the working conductor and the correspondingly small current, there need be no trouble on this score, and in any event the case is far less difficult to deal with than that of the direct-current system with its liability to electrolytic troubles.

Having regard to these and other similar considerations, it seems clear that on almost every count the alternating-current system possesses points of advantage over the direct-current system; the only, but apparently insuperable, obstacle to its adoption was the lack of a suitable single-phase motor, and as we pointed out some weeks ago, this want has now been filled. On the other hand, the excellent results obtained by Mr. P. V. McMahon on the three-wire D.C. system, an account of which is concluded in this issue, cannot be ignored. We anticipate, therefore, that a new battle between the systems—A.C. *versus* D.C.—is now approaching; it will be the duty of electric railway engineers to weigh most carefully the respective merits of the combatants—and may the fittest survive!

The Science of Steam Generation.

Mr. F. J. Rowan never writes on technical subjects other than well, and in his article on the science of steam raising, which appears in *Cassier's Magazine*, he advances many points of interest. Mr. Rowan is, we believe, an upholder of water-tube boilers, in principle, at least, and looks upon shell boilers as mere growths from the kettle. He regards steam generation as a combination of several processes:—(*a*) Combustion, (*b*) Heat Transmission, (*c*) Steam Generation. A comprehensive view of the whole subject must, therefore, be taken.

As regards the first, he points out how the direct radiation of heat from the glowing fuel, or the actual contact of flame with the water-cooled surfaces of the boiler, has always been looked on as essential, with the result that frequently the too speedy cooling of the burning gases has resulted in extinguishing the flame. He pays a tribute to the labours of men like the late C. Wye Williams. The result of such labours has been that better efficiency of combustion has been secured, but the author enters a protest against this being taken as the sole measure of the efficiency of a boiler, for so much depends on the size of a boiler, and one cannot go to excessive sizes and costs in order to secure the last unit per cent. of possible efficiency. We must aim to secure the highest possible temperature in the furnace, so as to get the best rate of heat transmission, and the waste gases must be at the lowest practicable temperature, to which end combustion must be carried out with a minimum of air.

The author illustrates his meaning by figures for carbon and for petroleum, and by a diagram. In this and in the figures an error has crept into the theoretical minimum of air required per pound of oil. It should be one half, or thereabouts, greater than the figure given. The intensity of draught has much to do with the size of a boiler. Mr. Rowan throws out a suggestion which, though not new, is still a novelty. He considers that sooner or later fuel will be burned under pressure greater than atmospheric pressure. By doing this, and even only doing it so that the initial volume remained constant, we might secure higher temperatures than we now do, because the specific heat of gases is less at constant volume than at the constant pressure associated with atmospheric combustion. In the gas engine combustion does occur under pressure, but the system has yet to be applied to steam boiler work. Ordinary combustion carried on at 2 atmospheres pressure would result in an addition of 715° F. to the temperature, and a further 493° would result at 3 atmospheres. The proportion of CO_2 would be increased. It is concluded that mere mechanical difficulties will not always be allowed to stand in the way of this improvement.

We are heartily glad to see an engineer of Mr. Rowan's ability taking up the question of radiant heat as against flame and hot gas contact. The use of the radiant heat of the fire has been answerable for a century and a half of smoke. The importance of radiant heat is ascribed purely to imagination. We know that the *Engineer* upholds the idea, and we regret the influence thus brought to bear, because it is all against the use of refractory furnaces, and against perfecting combustion prior to cooling down the gases. Experiments are quoted to the effect that whereas in heating by radiation the rate of transmission varied from 3,820—8,540 C.G.S. heat units per unit area in unit time, when convection heating was adopted the transmission rate went up to 4,700—16,050 units.

On the second division of the subject the author does not consider that boiler design has been much modified by any consideration of the best conditions for heat transmission. It is a curious fact that very little more heat is required to produce steam of 300 lbs. pressure than steam at atmospheric pressure, yet the temperature is increased from 212°

to 415° F. Between 1 and 27 atmospheres the difference is only about 5 per cent. in the heat capacity of a pound of steam. The heat passed from fire to water does not go direct. It has to pass through the separating boiler plate, but clean plate has a large capacity for heat transmission. The average evaporation per square foot of plate surface varies from 2½ to 7 lbs., and is rarely as much as 10 lbs. The author believes there are solid grounds for believing that 50, 80, or even 100 lbs. of evaporation should be given by each square foot of heating surface, if boilers were suitably designed. Experiments by Mr. Long have shown from 101 to 140 lbs. of evaporation per square foot per hour, where the steam was 69° to 107° hotter than the water it evaporated, the heat-giving agent being steam, and not fire. Feed water heaters have been designed on the results obtained by different experimenters. Mr. Stromeyer has estimated from Miss Bryant's experiments that at 140 units per hour, the mean temperature of a clean furnace plate 1 in. thick will be 70° above that of the water. With thin tubes the difference of temperature is still smaller.

Various experiments are quoted to show the ratio of evaporation from the first and later portions of a heated boiler, and it is shown how as much as 50 lbs. evaporation per square foot per hour is safely secured, and how nearly 48 per cent. of the total evaporation of a Niclausse boiler came from the first three rows of tubes of 161 sq. ft. area, while the other 52 per cent. came from 484 sq. ft. of the later tubes. Here again, 34 lbs. of safe evaporation per square foot was obtained. It is shown that plates not covered by water will become dangerously over-heated in 2 to 4 minutes, and that greasiness of surface is worse than scale for assisting to overheat a plate, a film of grease only 0·01 in. thick being about equal to scale of 0·10 or clean plate of 10·0 in.

It is pointed out that heat is always applied to the bottom or lower parts of a boiler, hence the mixing up of water and steam. This mixing up of course must be productive of serious circulation troubles in such a boiler as, say, the Belleville. The author appears to have these ideas also, for the water cast up with the steam in a small tube boiler cannot have the same temperature as the steam. He quotes from an article in the Electrical Review, by Mr. W. H. Booth, to show the enormous circulation there must be in small tube boilers. Mr. Thorneycroft has actually measured the circulation in his boiler, and Prof. Watkinson has also shown how great such circulation must be. All this points, in the author's opinion, to a defect in our methods of applying heat. It is interesting in this connection to think out what would be the action in a Belleville boiler if heat were applied first to the upper parts of the long tubes, the hot gases passing downwards, and, let us say, escaping by way of an economiser.

It certainly does strike us that some of the trouble with the Belleville system would thus be eliminated, for there would be a free outlet for steam from the top tubes, and the lower tubes would be less likely to become filled with steam, and were they to do so it is very unlikely that they would approach a red heat. Obviously where steam is formed in small vertical tubes, if it escapes vertically and alternating with plugs of water, it is very difficult to see how the enormous circulation can fail to take place. Of course, the restriction of circulation has not been looked upon as a desirable thing in tubular boilers; but presumably Belleville did attempt to restrict circulation. In the Solignac boiler the water inlets to the tubes are restricted to an area of about one-tenth that of the tubes, and certainly in the lower tubes most of this water is all converted to steam, and the boiler gives a large output from a small total volume. It would be interesting to try the effect of reversing the flow of gases in this boiler, though, really, it is constructed practically to carry out already very much the ideas which Mr. Rowan advocates. The article concludes with a reference to the movements of and stresses in boilers due to heat and pressure.

THE DESIGN OF DIRECT-CURRENT MACHINERY.

By VAL. A. FYNN.

(*Continued from page* 54.)

Table IV. shows the same machines wound for 230 volts. The irregularities arise from the fact that in many cases the same winding has been used for both voltages, the wires being parallel for the lower.

Table IV.—230-Volt Machines.

Distinguishing No.	Revolutions per minute.	Output in B.H.P.	Armature space factor.	Field coil space factor.	A.T. per inch circumference.	
					Normal.	For crane work.
1	1,150	2	·177	·403	169	240
2	920	3	·21	·453	223	360
3	840	5	·245	·443	240	380
4	825	7·5	·248	·48	259	390
5	800	10	·268	·502	232	350
6	760	13	·234	·488	196	355
7	700	18	·24	·518	192	345
8	700	25	·25	·526	205	380
9	650	32	·26	·537	226	415

The column giving the ampere-turns per inch circumference for these motors when wound for crane work, comes nearer to showing their real commutation capabilities. It must be remembered that for this duty the motors must run satisfactorily in either direction with fixed brushes; these, therefore, must be in the centre of the neutral zone, and they must stand at least 50 per cent. momentary overload. These motors do it sparklessly.

To show what very favourable values can be obtained even with such small machines when the question of temperature rise is waived, and the sparking limit only taken into account, as for crane work, the Steinmetz coefficient is not available, and we must turn to the one proposed by Kapp, which takes speed into account.

By "useful material" we understand in this case the whole shell of the machine, without the end covers however, the poles and field coils, the armature copper and iron without the shaft or pulley, the commutator copper without the socket, brushgear, or rocker.

In conclusion, the writer would add some remarks on the actual design of these small machines.

He thinks there is no doubt that a small machine, in order to be commercially successful, must be designed on the lines of reducing labour at the expense of material. It is clear that the number of ampere-turns per inch circumference will have a great effect on the cost of winding, and should be kept low. It is not possible in these small machines to work this figure up to the maximum permissible as far as sparking is concerned, simply because mechanical considerations preclude the proportionate diminution of the rest of the machine, and it becomes impossible to obtain sufficient cooling surface; hence the low values for normal work chosen in the series here described.

Another reason for keeping the A.T. per inch circumference low is the very poor space factor for those small wires, and the commercial advantage of being able to use the same design with suitably altered windings, for crane, hoist, and similar work.

In this, as in most other cases, the happy mean is the best; increase the weight certainly, but only as long as by so doing you can reduce the labour sufficiently to turn the machine out for less money, and bear in mind at the same time that a small machine in order to be saleable must be handy, and therefore not too heavy or too bulky.

It is surprising to see how many poor designs from the sparking point of view are still to be found on the market, notwithstanding these favourable conditions.

When designing a series of small machines it is always advisable to settle the proportions for the highest voltage and lowest speed likely to be normally required; by adopting any other course one runs the risk of finding that not sufficient room has been allowed either for the field coils or

for the armature conductors when the time comes to wind the machine for the above conditions.

From a commercial point of view, one frame should do for all voltages. On this consideration should, therefore, depend the settlement of the number of poles; the present tendency to use at least four poles in any size and in any kind of machine, is to be deprecated quite as much as the consistent avoidance some years ago of any machine with more than two poles and a slotted armature. There are strong reasons, both from the manufacturers' and the purchasers' point of view, why the smallest machines when used for the now usual high voltages should have not more than two poles. Here, again, consulting engineers ought to leave the manufacturer some scope and be content to specify the results to be obtained.

A small two-poler is bound to run better on high voltages; it allows of the use of windings which favour commutation under the prevailing conditions, and will give for this reason as well as on account of the greater angular distance between brushes, a better result with a smaller commutator.

It is true that a four-poler will require less total material for the same output, although not for the same quality of performance at high voltages, but the decrease will affect the cheap magnetic material more than the expensive copper, and the savings in the decreased number of field coils, smaller commutator, and decreased number of brushes, amply compensate for the excess in total material.

Furthermore, it is impossible in these small machines, when they have four poles and are otherwise rationally designed, to make the air gap as small as it should be if the field coils are not to carry more copper than necessary.

We find that in a well designed machine the ratio between A.T. required for the air gap and armature cross A.T. need not exceed ·75; on the other hand, on mechanical considerations, we would not like to recommend a clearance between armature and pole of less than $\frac{1}{8}$-in. a side—this clearance is quite sufficiently reduced by the thickness of the binding wires.

In a small four-pole machine these two conditions are incompatible and there must be too much copper on the field

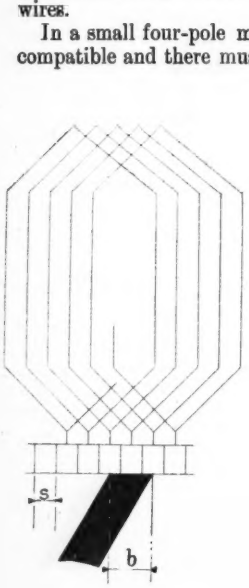


Fig. 23.

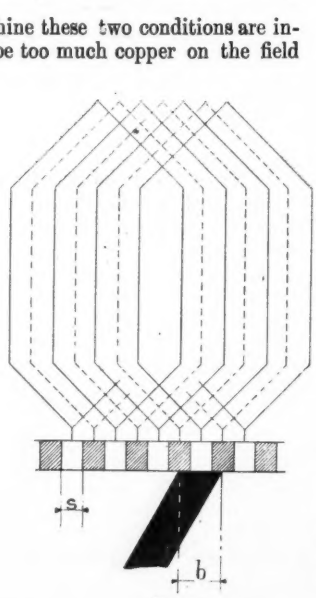


Fig. 24.

coils; if there is little copper nevertheless it points to poor efficiency, although owing to the greater cooling surface presented by the four coils, this may not become apparent through excessive heating.

The choice of windings that may be used is so great that it is perhaps sometimes a difficult matter to come to a decision. Each particular winding has, however, certain peculiarities which at once help one out of the difficulty. It would lead us too far to examine all the known schemes, we cannot do more than indicate our meaning in the case of a few typical examples.

According to the constants chosen for a particular design either a short or a prolonged time of commutation may be necessary. By time of commutation we understand the time during which any coil is short-circuited by the brush or brushes. Taking the multiple single winding, see fig. 23, calling s the width of one section, b the width of the brush surface in contact with the commutator, N the number of commutator segments, we have the time of commutation $= \frac{b}{s} \times \frac{60}{N \times \text{revs.}}$, if we disregard the effect of the mica insulation between the segments.

If we find that this duration of the short circuit is too much for our machine, we can use the multiple double winding in fig. 24, whether reentrant or non-reentrant, for which the time of commutation will only be—

$$= \frac{b - s}{s} \times \frac{60}{N \times \text{revs.}}.$$

To put it generally, we can write for multiple wound armatures—

$$T = \frac{b - s\,(n-1)}{s} \times \frac{60}{N \times \text{revs.}},$$

n being equal to 1 for a multiple *single* or a two-circuit *single*, equal to *two* for multiple or a two-circuit *double*, to *three* for a multiple *treble* or a two-circuit *treble*, and so on.

The above general formula also holds good for two-circuit wound armatures, using two sets of brushes only.

When more than two sets of brushes are used for two-circuit wound machines, the conditions are somewhat uncertain, as explained further on; but, assuming perfect contact between commutator and brushes and perfect interconnection between these, the conditions can be expressed as follows for a four-pole two-circuit double-winding, using four sets of symmetrically disposed brushes—

$$T = \frac{b}{s} \times \frac{60}{N \times \text{revs.}}.$$

Dissymmetry in the pitch of the various sets of brushes with two-circuit windings alternately lengthens and shortens the duration of the short circuit. The duration of the short circuit for a four-pole two-circuit treble-wound armature with four symmetrically pitched brush sets is—

$$T = \frac{b - \frac{s}{2}}{s} \times \frac{60}{N \times \text{revs.}}.$$

The number of turns in series which are short circuited under one brush, or between two brushes of equal sign, although not placed under the same pole, also gives us means of varying the commutation conditions. In this respect the two-circuit windings afford the greatest variety.

(*To be continued.*)

GAS-PIPE, COPPER AND COAL TRUCK.

By C. ALFRED SMITH, B.Sc., A.I.E.E.

In a previous article (Electrical Review, No. 1,353) some comparisons were given for the transmission of 6,000 B.H.P. by means of electricity and gas for a distance of five miles, and it was shown that while the "line costs" (neglecting the cost of the wasted units) were 0·126d. per unit with electricity, if gas were used the cost was reduced to 0·050d. per unit generated. It is now intended to consider a longer transmission of 25 miles, and for the purpose of comparison with other figures, which have been recently quoted, the amount of energy is taken at 1,000 KW. To complete the comparison, the possible economy of carrying coal instead of either gas or electricity is also considered.

During the discussion which followed the paper read before the Manchester Local Section of the Institution of Electrical Engineers by Mr. Earle last year, Mr. C. H. Wordingham gave the following interesting figures. He took the case of a 1,000-KW. main, and estimated that this would cost £1,800 per mile, that being the price actually paid for such mains at the time in Manchester. The cost of 25 miles of such mains would consequently be £45,000. Taking 10 per cent. for interest and depreciation of main, the annual cost comes to £4,500. Assuming a 25 per cent. load factor for the main, the number of units transmitted would be 2,190,000. This is, of course, on 1,000 KW. at the sub-station high-tension side. For complete comparison

with the gas engine sub-station, we have to reckon the number of units on the direct-current bus-bars, and consequently if we allow for the combined efficiencies of the transformers and rotaries at ·8 (which is the efficiency taken for the dynamos when direct coupled to gas engines), we find that the units metered on the D.C. side at the sub-station, works out at 1,752,000 per annum, or a line cost of 0·61d. per unit. Mr. Wordingham's figure was 0·49d. per unit, but his unit was metered at the sub-station end of the high-tension cable, and not at the direct-current switchboard.

Taking the corresponding case for the gas transmission, 1,000 KW. on the high-tension cables at the sub-station is equivalent to a load of 1,340 B.H.P. on the gas engines. Taking the efficiency of the dynamo at varying loads at ·8, this gives 1,752,000 units per annum, on the direct-current switchboard. Assuming that the consumption of gas is 70 cb. ft. per B.H.P.-hour, then the total amount of gas to be supplied per hour is 93,800 cb. ft. Now 70 cb. ft. of gas at atmospheric pressure weighs 4·179 lbs., and, therefore, ·001161 lb. of gas per second is required per B.H.P.-hour. After working out several cases, the author believes that the most economical initial pressure for a transmission of 25 miles (the final pressure to be atmospheric) is five atmospheres. In such a case the I.H.P. required for the compressor, for a maximum of 1,340 B.H.P. at the gas engine sub-station, is 218 I.H.P., which at £7½ per I.H.P., works out at £1,635 capital cost of the compressor. The diameter of the pipe required to carry this 93,800 cb. ft., works out at ½ ft., and the cost of the main, at £10 per ton of metal used, is £·20d. per foot run, where d is diameter taken in feet. This gives, for a main ½ ft. in diameter and 25 miles long, £13,200 as actual cost of the pipe. Assuming 2 ft. clearance on pipe all round, and the cost of excavation, pipe laying and filling in, at 2s. 9d. per cubic yard complete, then the total cost of excavation for 25 miles is £4,100. The total cost of compressor, main, and excavation, therefore, is, roughly, £19,000. Taking 10 per cent. interest and depreciation (the figure taken by Mr. Wordingham for the electrical cable), the annual "line costs" of the gas main is £1,900, against £4,500 for the electrical "line costs," or, with 25 per cent. load factor, it works out at 0·25d. per unit "line costs" for gas, against 0·61d. per unit for electricity.

These are comparative figures in order to take those quoted by so great an authority as Mr. Wordingham, but, to thoroughly complete the case, the cost of working the line (*i.e.*, the cost of the wasted units in the case of electricity, and the cost of running the compressor in the case of gas) should be included. In fact, in the case of electrical transmission, the additional cost of the units wasted by transformation losses in the sub-station should also be added.

It may be stated that, although the case is proved with regard to electrical transmission, it would be still cheaper to carry the coal in its raw state to the small gas engine station and there erect producers for generating gas on the spot. Taking the figures used by Mr. Wordingham, we find that he estimates that the cost of carriage of coal by rail is 1d. per ton per mile for distances not exceeding 30 miles, to which must be added 6d. per ton for upkeep of wagons and 1s. per ton for carting from the railway station to a local generating station. Now the estimated amount of gas to be used at the gas engine sub-station for developing 1,340 B.H.P. with a 25 per cent. load factor is 25,700 cb. ft. per hour. Assuming that 1 ton of slack coal will produce 140,000 cb. ft. of Mond gas, then the coal required per annum is 1,600 tons, and therefore the cost of carriage of quantity is approximately £300 per annum. It is true that at first sight this compares most favourably with the £1,900 per annum for the "line costs" with the gas scheme, but the difference would surely be exceeded by the extra costs due to generating Mond gas in sporadic quantities, rather than in one concentrated station where ammonia recovery would be possible. Probably the difference in the rates and taxes on the Mond gas plant situated 25 miles away and that of a plant situated in the centre of the city—obliterating for the moment such social considerations as the advantages of manufacturing the gas away from the city—would more than compensate for this £1,600 difference. It is true that centralisation for electric generation purposes is doubtful economy beyond a certain figure of, say, 50,000 B.H.P., but the same is not true for Mond gas, and there is every reason to believe that the larger the size of the station the more marked the reduction in the working expenses for producing 1,000 cb. ft. of the gas.

In such a problem the question of heating should most certainly also be considered, for it is in this respect that power gas will play such a prominent and humanising part in the years to come. Mr. Wordingham's steam-driven station using coal carted 25 miles would, according to his figures have to pay £540 a year for carrying the coal, and the difference between the line costs in this case and that of gas transmission, would be about £1,360. The comparison with the steam-driven station is even more strikingly in favour of the gas transmission, for the extra cost of running the station with a steam plant tells greatly in favour of the gas transmission. It may be well to emphasise the barbarity of manufacturing smoke in the centre of a city when it is possible to avoid it. Twenty-two years ago Sir Oliver Lodge spoke of a triple revolution which he thought would at that time immediately take place. He spoke of a revolution in methods of lighting, in heating, and in power production, and he hailed the introduction into our daily life of these processes and devices for smokeless combustion, with the greatest hope and enthusiasm, as a means of indefinitely benefiting the human race. At that time he believed that we were beginning to emerge from an age, "not of coal, for it will never be over until the coal-fields are exhausted, but of smoke," and that the world was entering upon an epoch, not of electricity only, but of electricity and gas.

It is strange that the suggestion given so many years ago by an eminent scientist has not been adopted more quickly, but those who have at heart the welfare of the dwellers and workers in cities will have sympathy with a system which will cure the smoke nuisance. The methods of producing the cleanest and most healthy power and lighting agent at present in general use are almost coarse, certainly crude, in the working, and while it is honestly believed that the method of gas engine sub-stations would be found to be most economical, from a financial point of view, for supplying a city with electricity for lighting and power purposes, it is certainly far better when viewed from a more lofty standpoint—the general improvement of everyday conditions of living. Where there are to be found advantages on both sides of the question (sentiment and pocket), there seems every reason to believe that some such scheme will be adopted in the near future.

One curious thing is shown by the above mentioned figures. For "transmission" costs only it seems that it is cheaper to carry coal by rail than to convert it into gas and send the power by piping; it is, however, cheaper to send power in the form of gas by piping than to convert it into electricity and send it along copper cables. Perhaps, if the labour conditions in vogue in China (where the labourer's wages are exceedingly small), held in this country, it might be even cheaper to hire porters to carry coal than to use railways!

SHOP MANAGEMENT.

By C. W. HILL.

(*Concluded from page* 80.)

THE important point in which Mr. Taylor's system differs from that of Mr. Halsey, is that in the latter, the standard time for a job is the quickest which happens to have been recorded, and as already pointed out above, this leaves the way open for deceit on the part of the workman. In order to avoid this haphazard system of timing, the author has invented and established a scientific method of time study, in which the times of the elementary processes which form a complete job, are accurately determined; thus, for example, in the case of a man loading pig-iron on to a car, the elements should be:—Picking up the pig from the ground or pile (time in hundredths of a minute), walking with it on a level (time per foot walked), walking with it up an incline to car (time per foot walked), throwing the pig down (time in hundredths of a minute), walking back empty to get a load (time per foot walked). Dealing with this particular class of work, the author states that on day work between 12

and 13 tons of pig-iron per man per day had been carried from a pile on the ground up an inclined plank, and loaded on to a car, by the average pig-iron handler. After a careful study of the elementary times, the elimination of idle time, and the establishment of differential piecework prices, the quantity dealt with per man per day became from 45 to 48 tons, the increase of wages per day which the men earned being 60 per cent.

Dealing with work of a higher class, such as that which is done on machine tools, the author gives forms which illustrate the whole process, including the times required to set a job in the machine, to set the tools, to do the work itself, and to take the job out and put it back on the floor.

Each man in an establishment, high or low, should daily have a clearly-defined task laid out before him. This task should not in the least degree be vague or indefinite, but should be circumscribed carefully and completely, and should not be easy to accomplish. Each man's task should call for a full day's work, and at the same time the workman should be given such conditions and appliances as will enable him to accomplish his task with certainty. He should be sure of large pay when he accomplishes his task, and when he fails he should be sure that, sooner or later, he will be the loser by it.

In order that the foregoing principles may be carried out in the most effective manner, the author further proposes to abandon what he calls the present military type of organisation, and to establish what he describes as a system of functional management, the most marked outward characteristic of which lies in the fact that each workman, instead of coming in direct contact with the management at one point only, namely, through the gang boss or foreman, receives his daily orders and help directly from eight different bosses, each of whom performs his own particular function. Four of these bosses are in the "planning room," and of these, three send their orders to, and receive their returns from, the man, usually in writing. Four others are in the shop, and personally help the men in their work, each boss helping in his own particular line or function only. Some of these bosses come in contact with each man only once or twice a day, and then for a few minutes, perhaps, while others are with the men all the time, and help each man frequently. The functions of one or two of these bosses require them to come in contact with each workman for so short a time each day, that they could perform their particular duties, perhaps for all of the men in the shop, and in their line they manage the entire shop, while other bosses are bound to help their men so much and so often that each boss can perform his function for but few men, and in this particular line a number of bosses are required to perform the same function, each having his particular group of men to keep. Thus the grouping of the men in the shop is entirely changed, each workman belonging to eight different groups, according to the particular functional boss whom he happens to be working under at the time.

The planning room to which the author refers is a room in which the best way to do each job, and the time it should take, are planned out, and written instructions to the men are entered up on suitable forms.

The foregoing forms a general abstract of Mr. Taylor's paper, which is well worth study in full by all who are interested in management or matters relating to the organisation of labour. To those who contemplate adopting the differential piece rate system or the premium plan in their works, the figures which Mr. Taylor gives, showing the percentage of increase of remuneration above the normal rate, which he has found necessary in order to get the men to put forward their best efforts continuously, will be of special interest, especially as they are the result of experiments and not of theories. In England it is usually considered that a man, irrespective of his particular trade, working on piecework should be allowed to make 25 per cent. more than the usual wage, and if he earns more than this, it is usual to cut down the piecework prices. Perhaps, in the face of Mr. Taylor's figures, this may be the reason why some of the attempts to establish piecework systems have been unsuccessful. The establishment of a daily task is certainly a desirable arrangement, and offers no particular difficulties in the case of a man whose work is of a routine character or who is engaged on repetition work; but in the case of machinists and fitters, whose work necessarily changes from day to day, it must be a matter of some difficulty to arrive at a means of establishing a definite daily task for them. There appears to be an idea that with either the differential piece rate system or the premium plan, it is not possible for employers to cut down the rate if they think that their men are making too much. This, however, is not at all the case, as differential prices can be reduced, and so also can the standard time under the premium plan. The essential point, however, of Mr. Taylor's differential piece-rate system is that, along with it, he has established his scientific method of "time study." By this method he has been able to settle accurately what time a job should take, and, having settled this, he lets the workman make as much as he can, until, by the adoption of improved machinery or the invention of improved methods, he finds, by his method of time study, that the time in which the job can be done can be materially reduced, and it is this system of accurate time study which distinguishes his piecework system from the usual method of working on piecework.

THE PREVENTION OF FLASHING AND HAMMERING AT TROLLEY EARS.

THE reason why there is flashing and hammering every time a trolley wheel meets an ear, is simply because the line is swollen out at this point by the overlapping of the ear. This

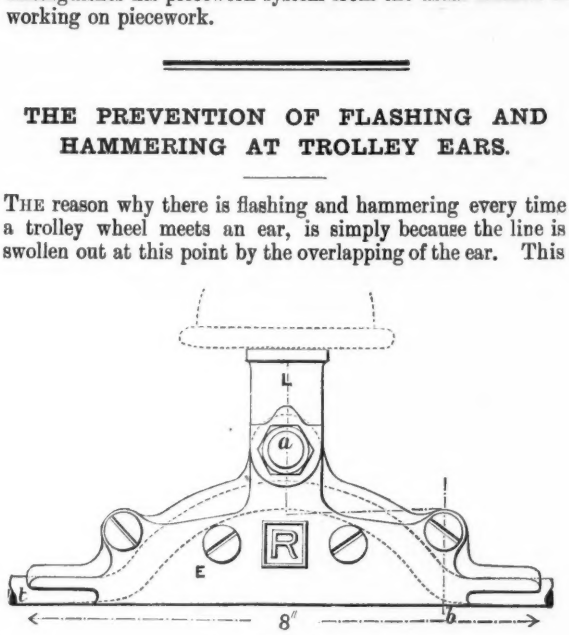


FIG. 1.

protuberance forces the trolley head down, causing it to jump and the current to arc. A method of prevention, and one much in favour in the United States, is to use "figure 8" trolley wire, but besides the heavy initial cost, this section of wire offers serious constructional difficulties.

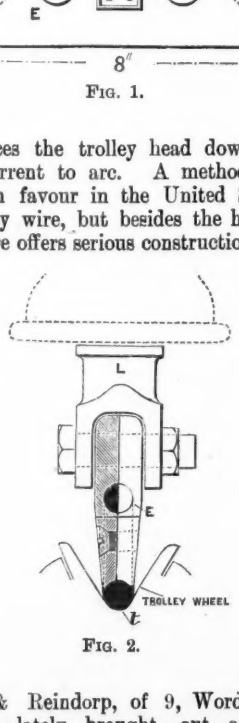


FIG. 2.

Messrs. Rea & Reindorp, of 9, Wordsworth Avenue, East Ham, have lately brought out an entirely new ear, which they claim will give perfectly smooth-running. Its contruction is as follows:—Instead of the wire going straight through, as is usual, it is curved upwards for a few inches of its length (fig. 1). The wire is held in position by two plates, suitably grooved and bolted together. By these means, as far as it affects the trolley wheel, the ear does not protrude beyond the wire

(fig. 2). We are informed that experiments carried out on the ear have fully borne out the claims of the inventors.

The "R squared" ear, as it is called, is cheaper than or as cheap as the ordinary sweating or mechanical ear, and has the advantage of being practically everlasting; it can

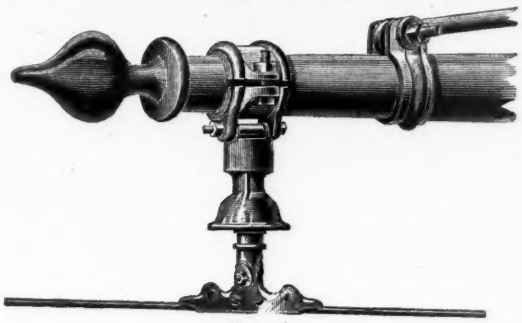


Fig 3.

be removed and used again should occasion require. In the case of the ordinary ear the wire is held in a very ineffectual manner, but with the "R squared" type, precisely the opposite is the case. It is unnecessary to point out any further advantages, although it may be mentioned that the suspension lug L (figs. 1 and 2) gives the line an automatic compensating action that cannot be obtained with the ordinary ear, without the addition of a separate arrangement. Fig. 3 shows the complete fitting attached to a bracket arm. The practical utility of such an ear will be patent to every tramway man.

THE EDUCATION OF AN ELECTRICAL ENGINEER.

By W. G. RHODES, D.Sc., M.I.E.E.

Our attention has of late been repeatedly drawn to the question as to how to train a youth to best fit him for occupying a position of high responsibility in the electrical engineering profession.

The "Correspondence" columns of the Electrical Review have ventilated the opinions of some people, and at the Glasgow Section of the Institution of Electrical Engineers, Prof. Baily, a teacher of wide experience, has given to the world his ideas on the subject.

There are still a few belated individuals who think that the workshop is the only necessary school, and who taboo the class room as worse than waste of time, banning it as a school for laziness.

I think we may, however, agree that some combination of theoretical and practical training is a *sine quâ non* for the training of one who is to be more than a mere artisan.

To thoroughly understand the design of any electrical machine or appliance, or to properly grasp the fundamental principles underlying the practice of any branch of electrical engineering, demands a certain amount of scientific training which is not to be picked up in an ordinary engineering workshop. A practical knowledge of the strength of materials may enable us to *guess* at the diameter of shaft necessary to stand a given torque, but much more than empirical information is required to determine the number of turns for the field winding of a direct-current motor to produce a given voltage at a given speed, and for a given armature winding. Where is a designer to learn about magnetic reluctance?

Even with direct currents some theoretical knowledge is required which demands more than rule-of-thumb work. If we encroach upon the subject of alternating currents, our essentially practical man at once gets out of his depth, and has to take his instructions—for he can do what he is told—from someone who knows, from someone whose knowledge is not limited to what he has previously done, but whose scientific training is such as to enable him to predict what will happen if certain alterations in his previous methods are adopted. It is, of course, advisable, nay, essential, that such a man should be able to express himself in language which the practical man can understand, which is almost universally the language of the drawing board. In other words, the theoretical man to be of much use, must also be a draughtsman.

From my experience I do not consider it at all necessary for a successful engineer to be a mechanically-practical man. He should know a good job or a bad one when he sees it, but that knowledge can be obtained by observation. Life is too short for him to qualify himself to perfection in the practical work as well as to master the theory, and it is the latter which pays him best. If he has funds at his disposal, and knowing the latter, he can pay practical men—artisans—to do the former.

Assuming now that a responsible electrical engineer must have this composite practical and theoretical training, how can he best obtain it? I think that Prof. Baily's scheme is good, and that his "sandwich" method would work well if only it could be put into practice. The difficulty, however, in England, is to get the co-operation of manufacturing firms or contractors. What firm will undertake to engage a man, or youth, for a few summer months, and allow him to prosecute his studies at a college, say, from September to May?

Let me here give a word of advice to some enterprising manufacturer or contractor; if he takes the advice, he will reap the benefit a thousandfold. Let him inquire, towards the end of September, after the session is well begun, about the most promising students at various technical colleges in the kingdom, and consider only those who are just commencing their technical training. Let him select the number he requires and enter into an agreement with them, or their parents, to the effect that these students shall follow courses prescribed by him and the professor, or teacher, which will qualify them theoretically for his particular line. Let him further speculate by undertaking to engage them at a fair living wage at his works during the vacations, and after the college course is ended to place them on the permanent works staff. Such a speculative employer would soon have such a staff as to leave his competitors behind.

Would that manufacturers and technical colleges could thus agree!

Another point I would yet draw attention to. It is highly essential for the commercial aspect to be studied, and I think that all technical colleges should have classes in which instruction is given in such questions as costs of material, labour, establishment charges, commercial law, &c.

I once heard one of our most prominent contractors say that all technical experts should be placed in a glass case. His experience was that the employment of scientific experts ran away with all the profits! Why? Because they did not combine their scientific training with a commercial one.

And now just a word for the teacher. We require teachers qualified to act in co-operation with the manufacturers, that is, teachers whose qualifications are a combination of the theoretical and practical. How many such teachers are there? Scarcely any! Why? Because their employers do not understand the importance of their vocation or its value, and will not provide adequate remuneration. If a teacher is thoroughly competent, he soon leaves the profession for a more remunerative position. Why should a man receive less salary than the students he himself has trained? Such was my experience as a teacher, and such is the experience of every teacher I know.

The teaching profession must be more liberally recognised if good men are to be retained. They provide the brains of our electrical industry, and often do not receive the salary of a leading draughtsman.

I only know of one professor of electrical engineering receiving as much as £1,000 a year, whereas it is but a second-rate engineering or contracting firm that does not pay its manager far more. It is a short-sighted British policy. Perhaps, as usual, we shall profit by dearly bought experience. A change in this respect would have more lasting effect than a change in our fiscal policy.

As regards evening classes, they are wearisome to the flesh. No one, whatever his age, can work from 6 a.m. till 5 p.m., and be fit for concentrated thought and attention till 10 p.m. It is all very well for the most robust of the artisan class to attempt this, but it is only the exception who will attain it. It requires exceptional physical stamina to endure the strain.

ROYAL COMMISSION ON LONDON TRAFFIC.

THE Royal Commission on London Traffic, of which Sir David Barbour is chairman, resumed its sittings, after the Christmas vacation, on Thursday, January 7th.

The first witness called was Mr. J. W. BRADLEY, the city engineer of Westminster, who, in the course of his evidence, said that in a single year some 11,000 different openings, amounting to 110 per mile of street, were made within the City of Westminster. Besides these there were from 300,000 to 400,000 temporary openings of surface boxes, which lasted from three minutes to one hour and over.

Mr. STEPHEN SELLON, consulting engineer to the British Electric Traction Co., said that the result of the Tramways Act of 1870 had been to put a standstill to tramway matters in the country from the year 1880 to 1895. It was due to the purchase clause of the Act. Then the power of veto possessed by the local authorities was in many cases seriously abused. In giving the decision of the Parliamentary Committee of the Glasgow District Tramways Bill, Sir Lewis McIver, the chairman, had said: "The Committee find that the preamble of the Bill is not proved. But the Committee desire to put it on record that, in their view, the original scheme was a good one, and calculated to be of great service to the district, but it has been so mutilated and loaded with conditions by the conflicting interests and demands of the several local bodies, that at present it appears to be wholly unworkable." Sec. 43 of the Act of 1870 had been fatal to the interests of the public. Owing to the section, several lines had been over-capitalised. Financiers would only find money at exorbitant rates when the terms of purchase and length of tenure were in accordance with that section of the Act. It prevented companies from making any considerable improvements or extensions. There were other difficulties in the way of tramway enterprise. Procedure for obtaining powers was costly—the three methods, provisional order, light railway order and private Bill had a common characteristic costliness, and under any one of the systems tramway promotion was a lottery.

In reply to the CHAIRMAN, WITNESS said that he did not consider that the local authorities should have a veto, as that power had been abused so seriously in the past, though the local authorities should have every consideration. A Tribunal should be appointed to deal with all tramway matters, and in constructional matters should have the advice of a technical man.

On Friday, Mr. SELLON, continuing his evidence, said that in the past, 2½ per cent. of the capital employed had been spent on the promotion of those tramway Bills which had been passed. The Light Railway Act had been a step in the right direction, and a similar tribunal should be appointed to deal with London traffic. He considered that the Light Railway Commissioners should be numerically added to, and should then deal with applications from all over the country, and not from London alone. A technical Commission should also be formed to deal with structural matters. The technical Commission should make a comprehensive survey of the Metropolitan area, and should draw up plans showing arterial thoroughfares and necessary widenings and straightenings as well as tramways; this he called "Hausmannising" London. Passing to a consideration of the economic aspect of tramways, witness said that on a tramway a horse was worth 20 per cent. as regards vehicle miles, and 78 per cent. more as regards passengers, when compared with omnibuses. Five horses on a tramway would do the work of nine horses in 'buses. Some claim had been made for automobiles on the ground of "overtaking power as against tramway vehicles." That power had, he considered, been over-rated, for, as the traffic increased on the road, the opportunity of overtaking diminished. The highest use was made of a road when the traffic was graduated in parallel lines according to relative speed, and tramways had a graduating effect, and were not an obstruction to other traffic, as had been so often urged. Mr. Sellon then put in maps, which he explained at some length, showing a scheme for the construction of tramways in the heart of London itself. The routes suggested were as follows. East to West routes:—

Route No. 1.—Commencing on Victoria Embankment and proceeding down Queen Victoria Street, Cornhill, and Leadenhall Street (east going line), Lombard Street, and Fenchurch Street (west going line) to join existing tramways at Aldgate.

Route No. 2.—Strand, Fleet Street, Ludgate Hill, St. Paul's Churchyard, Cannon Street, Eastcheap, Great Tower Street, Tower Hill, Upper East Smithfield, joining existing lines at London Dock end of Leman Street.

Route No. 3.—Oxford Street, Holborn, High Holborn, Holborn Viaduct, Newgate Street, Cheapside, Poultry, Mansion House to Aldgate, as route No. 1.

Route No. 4.—Leaving route No. 3 at Holborn Circus, then Charterhouse Street, Smithfield Market, Long Lane, Barbican, Beech Street, Chiswell Street, Finsbury Square, Sun Street, under Liverpool Street Station, and along Brushfield Street to join existing tramway in Commercial Street, Spitalfields.

Route No. 5.—Leaving No. 3 at Hart Street, Bloomsbury, would proceed to existing tramway in Theobald's Road, north to south routes.

Route No. 6.—From existing terminus at south end of Gray's Inn Road to Holborn Circus, then down St. Andrew's Street, St. Bride's Street, New Bridge Street, Blackfriars Bridge to Blackfriars terminus.

Route No. 7.—From existing terminus in Farringdon Road to join No. 6 at Ludgate Circus.

Route No. 8.—From existing tramway in Goswell Road along Aldersgate Street, St. Martin's-le-Grand, Gresham Street, King Street, Queen Street, Queen Street Place, and then over Southwark Bridge to tramway in Southwark Bridge Road.

Route No. 9.—From existing terminus in Finsbury Square along Finsbury Pavement, Moorgate Street, Princes Street, King William Street, across London Bridge, along Borough High Street, to tramways in Tooley Street and Great Dover Street.

Route No. 10.—From existing terminus in Shoreditch, along Norton Folgate, Bishopsgate Within, Bishopsgate Without, Gracechurch Street, and so to join No. 9 at King William Street.

Route No. 11.—A line to connect 9 and 10 by way of Finsbury Circus, East Street, Blomfield Street, Liverpool Street. That last line would serve for passengers to Liverpool Street station and to the North London Railway termini.

On the south side of the Thames, he thought the following route would tend greatly to benefit the public:—From the existing tramway in the Borough, along Southwark Street, Stamford Street, York Road, to Westminster. At Westminster the line might cross the bridge and connect with lines on the Embankment and down Victoria Street. It might be found advisable, said witness, dealing with the question of tramway subways, to carry them clear of the City, and make them emerge in open spaces, such as parks, &c. Deep-level tubes under the river could not be made to serve as portions of lines in shallow subways.

The Commission adjourned.

THE BRISTOL FIRE: ITS PROBABLE CAUSE, EFFECTS AND LESSONS.

THE following is the gist of a communication which we have received from Mr. H. W. Clothier:—

PART 1.—PROBABLE CAUSE AND EFFECT.

Judging by recent publications, expressions of opinion and practical experiences in the many electricity supply stations in this country using the Ferranti cellular switchgear, the Bristol breakdown which has been freely reported in the technical and daily Press, must have come as a surprise, even to those who hold the most pessimistic views respecting this particular type of gear. The number of these switchgears in use and the remarkable freedom from serious accidents and disturbances, even when working on high voltages, have created a confidence in the design, so deep rooted that the experience at Bristol must be looked upon as a unique exception. At the same time the writer hopes that a study of the probable cause and effects may be beneficial to those who are interested in the design or working of H.T. switchgears, and that it may help to fore-arm us against a repetition of such catastrophes which, exceptional though they may be, do an immense injury to the electrical industry, not only locally, but universally.

System.—The alternating-current system at Bristol consists of two generating stations. The first was built in 1893 at Temple Back, and has since been extended so that it now contains 10 alternators (four 400-KW., four 210-KW., two 88-KW.), the switchgear being made in the year 1899. This gear has since been extended to include 40 circuit panels. The generator switchgear, as it was before the fire, is shown in fig. 1.

The Avonbank station has only recently been built, and contains four 750-KW. alternators. The whole of the distribution is from the switchgear at the old station, this gear being interconnected with the new Avonbank switchgear by four trunk mains.

Just before the accident the summation instruments indicated a load of about 3,000 KW., which was being supplied by two 400-KW. steam alternators running at Temple Back, and four 750-KW. steam alternators running at Avonbank; the entire plant running in parallel.

The Interruption.—From a moral point of view the most serious result was that soon after 5 o'clock on Wednesday evening, December 23rd, 1903, the consumers' lights flickered, went dull and then disappeared altogether. Some portions of the Corporation supply were re-established at 2.30 the following morning, but despite the strenuous work of the Corporation officials and men, it was impossible to supply the entire locality before 8 o'clock in the evening of December 24th; thus there was a discontinuance in the supply to some districts for about 27 hours.

Damage.—As compared with the foregoing, the direct pecuniary loss due to the injury and destruction to the apparatus and building is slight, and would presumably be covered by insurance. The effect of the failure on the switchgear was illustrated in the ELECTRICAL REVIEW of January 1st, from which it will be seen that several of the fuse and switch panels on the machine portion of the gear were literally burnt out by the arc and pulverised by the heat therefrom; the remainder was damaged and placed out of commission by the conflagration which ensued.

Cause and Effect.—An examination of the *débris* leads one to suppose that one or both of the machine fuses (marked X, fig. 2) blew with a loud report due to an excess current passing through them. This action was immediately followed by a severe arc melting the metal contacts of the fuses and burning through the 2-in. horizontal slate above. The arc quickly fused all metal within the darkest patch shown on the figure, and destroyed all slate, porcelain, &c., within the shaded patch shown. Even the wall shared in this treatment, a portion of it covering a surface of 3 or 4 sq. ft., and at least 2 in. deep in parts has disappeared; the hole being deeper at places where the metal conductors were most severely damaged by the arc. Such an arc, fed by two 400-KW. machines from one side, and by four 750-KW machines from the other side, may well be imagined.

The hopelessness of endeavouring to extinguish it was at once appreciated, and steps were immediately taken to shut down the

Temple Back machines on the stop valves, and to instruct Avonbank by telephone to follow suit.

It will be obvious that some appreciable time, possibly three minutes or more, elapsed between the commencement of the outbreak and the cutting off of the supply; yet the electrical destruction—*i.e.*, that directly due to fusion by contact with the arc—was confined within the four machine panels. A serious conflagration, however, must have been almost simultaneous with the formation of the arc, this being started possibly by an electrical failure on the cables, by the dropping of molten metal, or the heat from the arc, on the linoleum and platform floor covering, and also on the insulation over the inner conductors of the cables adjoining the terminals under the bottom horizontal slate of the switchgear structure (see fig. 3.) The ignition and combustion of this highly inflammable material was doubtless rapid, and the heat therefrom must have been intense. The flames quickly spread over a wall space of about 40 ft. The flames also leaped up to the wooden structure supporting the roof of the building, the assistance of the fire brigade being requisitioned to extinguish the fire.

The Re-establishment of Supply.—According to authentic reports, it was after seven o'clock, or one hour and a half after the outbreak, that the building was entered, and the damage investigated by the aid of oil lamps, which had to be procured for the purpose, the gas service being rendered unavailable by a local disturbance. No time was lost by the officials in preparing to resume the supply. A large gang of men were engaged upon clearing away the remains of the cables, &c., from under the switchboard platform. Steps were promptly taken to join up the trunk mains from Avonbank direct with some of the distributors. This meant a great deal of excavating, it being necessary to open up the road adjoining the works in order to make connections to sound cables. Ultimately the system was joined up solid by the aid of temporary bus-bars and connections, the whole demand for load being taken up by the machines at Avonbank and one generator at Temple Back.

Part 2.—The Faults.

Let us assemble as concisely as possible, firstly, the respective faults developed at the origin of the trouble; and, secondly, the obstacles which handicapped the speedy re-establishment of the supply:—

First.

1. Primary fault at present not disclosed, on some part of the system, causing excess current through machine fuses.
2. Failure of machine fuse or fuses, and the consequent development of an arc on the switchgear.
3. Fire spreading to cables, platform and roof.

Secondly.

4. Time requisite to shut down the machines and so stop the arc.
5. Time taken to extinguish the fire.
6. Time spent in obtaining light and examining the damage.
7. Time required to clear away damaged cables and to make temporary connections.
8. In the meantime, Avonbank, containing a sound switchgear, cables, and uninjured machines, was standing idle and helpless.

Let us also consider in the same sequence the conditions which might have saved or reduced the extent of the damage and the length of the interval which elapsed before the supply was fully re-established.

1. The primary fault, being foreign to the switchgear question, need not be commented upon here.
2. The fuses were of an obsolete type, and might have been replaced by a more satisfactory and later design, or dispensed with altogether on the machine circuits.
3. A less inflammable material on the floor and on the cables would have reduced the intensity of the fire. The question of insulation on the switchgear platform would seem to be an important one. In the absence of a better suggestion forthcoming, glass set in a metal frame may be used to advantage.

The absence of inflammable material from the roof structure would obviously minimise the extent of the damage resulting from a fire inside the station.

4. Had it been possible to get near the trunk main switches, Avonbank might have been isolated. Although this would have shortened the time during which the arc was maintained, it is very questionable whether any other material saving would have been effected, as the fire seemed to get an instantaneous hold upon the gear and its contiguous parts.
5. The time spent in extinguishing the fire when once fairly started could of course only have been avoided by absolute prevention of the fire in the first instance.
6. Some of the inconveniences caused by the absence of light under similar conditions would be avoided by the systematic installation in central station of flare lamps or acetylene lamps which must be kept in a safe position and in regular order, so that they can be lit up immediately there are signs of impending trouble.
7. What seemed at one time to be ample provision against a failure was the introduction, at the instigation of the engineer, of triplicate bus-bars; without prejudice to the policy of duplicate bus-bars for convenience under ordinary working conditions, it must be admitted that the complications are of very little service in case of emergency. If the full advantages during and after an emergency are to be derived from the duplication of parts it must be complete. To cope with a failure of the magnitude that the one in question eventually attained, we should duplicate the entire switchgear and also the connections from the place at which the feeders enter the station.
8. Local conditions of moment which need not enter this discussion, were considered when it was decided to feed the whole of the area covered by the Corporation supply through the switchgear in the old station, and the possibility of the entire basketful of eggs, as it were, falling seemed at the time unlikely, but in the light of the past experience a much speedier resumption of the supply, at least to certain districts, could have been effected had it been possible to distribute from Avonbank, independent of Temple Back.

Part 3.—Possible Prevention.

There is but little doubt that the trouble originated from some error in the design, manufacture, erection or upkeep of some part or parts of the machine fuse panel, although it must be admitted that the greatest damage was wrought by the combustion of material contiguous to, although not actually the manufacturer's part of the switchgear. The fuse design was prepared some five or six years ago, at a time when there was not the same general appreciation of the importance of the central station switchgear, nor the same facilities for testing, &c., that exist at the present time. At that time the design in detail was considered satisfactory in use, although somewhat difficult to manufacture. A special factor to be considered was the necessity for a design of fuse and fuse panel which would occupy the same space as that taken up by an existing design then used for half the capacity; the reason being that at places where switchgear had been installed with provision on the slate frame for extensions, it was found convenient to double the size of the generators included in the extension schemes. After events proved the fuse troublesome due to over-heating and leakage of oil, although a switch designed at the same time under corresponding conditions gave better results, and is now being used to a very large extent.

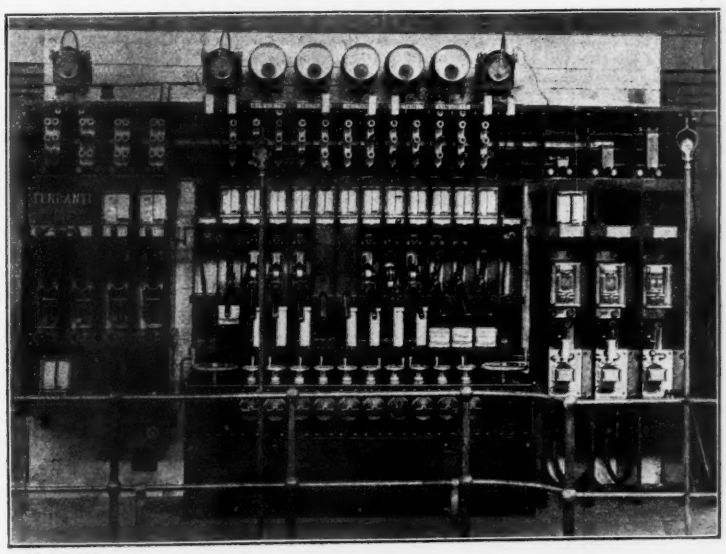


Fig. 1.—Main Generator Switchboard before the Fire.

Protecting Devices for Generators.—In the foregoing portions of this discussion it has been suggested that fuses should be eliminated from the generator circuits.

This introduces again a much discussed question on which there are three pronounced sides.

On generator circuits the use of:—

1. Fuses.
2. Reverse current or discriminating automatic circuit breakers.
3. No fuses or automatic devices.

Fuses—The first is admitted to be theoretically bad, because, amongst other well-known reasons, the sound machines are likely to be isolated at the wrong time.

Reverse Current Automatic Devices.—A really reliable device that would automatically open the generator switches on the reversal of current has long been sought for, but, unfortunately, those who have worked in this direction have found that whilst the device meets the requirements for high resistance faults, in cases of low resistance faults (*i.e*, short circuit on the armature, &c.) the low potential difference across the shunt coil, on alternating current systems, renders this apparatus inoperative and useless just at the time when reliability and certainty in action are most essential.

No Automatic Protecting Devices.—In the absence, then, of an absolutely reliable automatic protecting device for generators it is better to do without automatic protection. It is better to risk injuring the alternator than to cause a complete or even partial cessation of the supply to the consumers. The remedy is brutal, but soon over.

By removing the fuse from existing generator panels, space will be available for the addition of a reverse current indicator, which, by the glow of green and red lamps respectively, will show

whether the alternator is generating or taking current from the bus-bars.*

Proposed Stand-by Gear.—For the barest necessities it is proposed to arrange on the switchboard platform, or at any other convenient

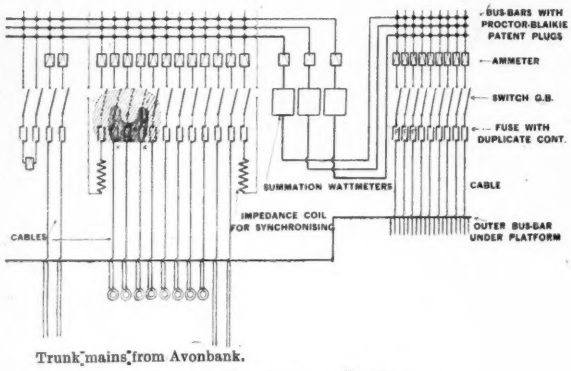


FIG. 2.—DIAGRAM OF CIRCUITS.

place at least 20 ft. away from the permanent switchgear, a system including an arrangement of connections and switch-boxes, one of these boxes being provided for each alternator installed. Each feeder has also a place in one or more of these boxes, the connections being arranged so that each machine can be run independently upon a group of feeders, the number of which will vary according to the size of the machine and feeders. Then, in the event of a breakdown placing the entire switchgear out of commission, the supply can be rapidly reinstated by the independent running of all machines for the time being on the several groups

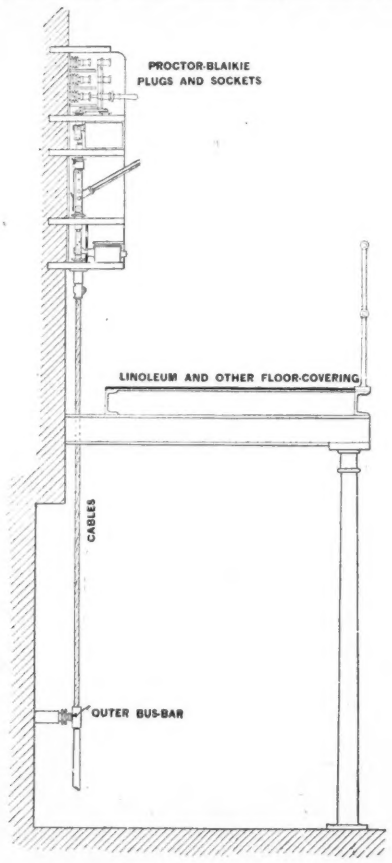


FIG. 3.—ELEVATION OF SWITCHGEAR.

of feeders which are respectively connected up solid. Arrangements are also made so that, in the event of any single machine being out of commission, the feeders, which were allocated to that machine, may be coupled up to the other generators.

The supply pressure may be regulated on the engine stop valve and governor, and indicated by a group of incandescent lamps, in series, connected to the alternator terminals, or preferably by a pair of lamps connected in parallel between the earth terminal and a tapping from alternator armature; or else the lamps may be connected across the secondaries of permanent instrument transformers at places where these are fixed near to the generators.

* Cowan and Andrews's "Control of Long-Distance Lines," Manchester Section of Inst. Elec. Eng. Recorded in *Proceedings*, Vol. 32, p. 9, 1903.

The system roughly sketched above affords a ready means of isolating for cleaning and other purposes, besides fore-arming against the complete or partial disablement of the permanent switchgear or connections inside the electricity works. It can also be used for another important purpose. Assuming that fuses are dispensed with on the generator panels, and a generator is showing signs of failure, rather than run the risk of shutting down the whole plant, the emergency switch of the doubtful generator can be closed, and its main switch opened. Now the doubtful generator can be isolated automatically by the feeder fuses blowing or by hand on the feeder switches.

The useful features of these operations are that the circuits are not actually broken under load, the operations merely diverting the current into other paths, and so the formation of a ferocious arc is warded off. And, moreover, these objects can be achieved on existing equipments at a very moderate cost and without any alteration to the existing switchboards, other than the removal of the fuses, which can be done whilst the several panels are alive.

It is not the intention to claim originality for the suggestions herein, for the principal features are merely the results of observation after the accident in question. But it is hoped that they or better ideas evoked by this discussion may allay the natural anxiety on the part of those engineers who have to ask themselves what they are to do to prevent a re-occurrence of the Bristol calamity.

The author also begs to recognise the information given by the Corporation officials at Bristol as to the occurrence inside the electricity works, and to appreciate the assistance rendered by the local daily newspapers in expressing the outside effects.

CORRESPONDENCE.

Letters received after first post on Wednesday morning cannot appear until the following week.

Waste of Energy in Tendering.

A number of gentlemen have written upon the above subject, but have apparently failed to sift this rather difficult question, or to offer a satisfactory solution thereto. A lot of this waste of energy (plus time, expenses and material) *could* be saved, if the question were tackled in a businesslike way.

To take a case in point. Say a firm wants a complete plant. A specification is issued (it may be by a consultant, or by a *relation* of an ordinary engineer, according to the wisdom of the principals of the firm wanting the plant) the specification contains particulars of boilers, steam engines' stokers (mechanical), economisers, dynamo, motors, arc lamps, lifts, the usual generalties, and a telephone installation.

This specification is sent out, in the case of a public tender, to all who are smart enough to make application therefor. Although this is a good way of issuing specifications, it is questionable sometimes, if even this system secures the very firms who are best cut out for the work.

In the case of unadvertised tenders, the firms who are lucky enough to have fastened their names on the memory of the ordinary engineer, or in the case of the consultant, who have done satisfactory work to his specification before, receive copies; it is quite a mistake if an outsider hears of the work. All and sundry, however, who do get the specification, start on the job and write, say (in the case of the electrical engineers tackling the work), to five different engine-makers (giving particulars of dynamo proposed, and asking for price, prints, weights and so forth of the engine offered), three boiler-makers, three stoker manufacturers, probably several lift specialists (asking them to quote less motors, which they will include), and finally to one or two contractors to quote price for the complete wiring and the telephone installation, which latter will, in turn, mean several suppliers of telephone apparatus being asked for quotations for suitable instruments.

In the case of the boiler stoker or engine-makers, the above procedure still obtains, only that so many dynamo-makers are asked for particulars of machines, to fix to their engines, &c.

When these sub-tenders come in to the tenderer, he goes through them, usually selects the cheapest tender that will suit his machines, &c., and the other sub-tenders in each section go into the waste-paper basket. Now this happens, say, in almost every case of 30 or 40 applicants for the specifications (if public), or a dozen ditto, if unadvertised.

Many firms, also, who are specialists for particular gear are applied to for prices for the same contract, by a dozen or more different intending tenderers, and have to send lists,

specifications, prints, photos and prices to all these, although some of the applicants can stand little, if any, chance of the work.

To the serious mind, this will at once suggest a picture of the terrible waste which takes places; and even to those who view the subject in merely a casual way, the waste must be obvious.

Now, if the specifications were drawn up in an ideal way by the consultant (whoever he be), a lot of this might, and *could*, be avoided.

The first step is to classify, divide, and schedule all the material required under the contract. Thus, a separate and distinct division and schedule (or to be quite clear, a separate and complete specification) would be issued, for (1) engine and accessories; (2) boilers and economisers; (3) stokers and accessories; (4) dynamo, motors, arc lamps, switches, telephones and sundries; (5) lifts and sundries; (6) wiring.

Engine-makers would apply for tender No. 1, and send in their estimate for this only. If boiler-makers also manufactured economisers and stokers, they would apply and estimate for Secs. 2 and 3. Each tenderer could tackle his own particular work.

If any firm were large enough to tackle the whole job, they would, of course, apply for the whole of the sections.

I shall no doubt be told the tenders would be chaotic, but if the consultant specified (say to the engine-makers) a particular speed, the inclusion of extended bedplate and half-coupling, a run under test with dynamo at engine-maker's works, and so forth, this and every other section would be quite clear and understandable.

To those whom I have referred to above as "specialists for particular gear," this would mean a great saving of energy, time, lists, specifications, &c., as in their particular case *they only* would be tendering direct, instead of through a dozen or more different firms, one only of whom, under the most favourable circumstances, can get the work.

It would also save those who would in the ordinary way apply to these "specialists" for their prices, as, of course, long inquiries, &c., stating particular requirements, would not then be needed.

To narrow down the thing still further, if the consultant stated in his specifications that engine and boiler insurance companies' rules must be adhered to, that the Institution rules (for electrical plant) must also be conformed to, &c., and simply gave the other particulars such as type, horse-power, voltage, speeds, amperes, lift, and so forth, instead of a wordy description and explanation of what was required (such description and explanation being very often open to varied translation on account of density of language used) the specification would be an admirable one, and it would be a great help and saving to intending tenderers. Moreover, this would cut out the many "little and marvellous" whimsicalities and trivialities of the compiler, which would be a further boon.

Manufacturers would especially feel the benefit of such an arrangement, as all time, energy, material, &c., saved under such a system could be devoted to the seeking of *fresh* fields and pastures *new*; and a proper utilisation of the saved time, &c., would mean a chance of a *larger number of orders and a bigger turnover*.

No doubt many correspondents will tell me that a number of specifications are now so divided; but to this I answer that the *preponderance* of specifications issued invite tenders for the *complete work*. Moreover, even (as in some public tenders) where the specifications *are* sectionised or scheduled in good form, the good intended by such arrangement is almost invariably nullified, owing to the consultant, clerk, secretary or engineer, as the case may be, suggesting that it would be much better if the work was entrusted to one firm, as there would only be one set of people to deal with, one set of guarantors, one account, &c.

This "one-firm" contract may mean a little saving in routine, and is easier to handle from a consultant's point of view; but when it is considered that the "one firm" have to have a profit on each sub-contractor's work, it is questionable whether the saving and convenience, on the one hand, is not more than counterbalanced by the other.

One other point which I should like to suggest is, that, by a little organisation, it would be easily possible for the "Manufacturers'" and "Contractors'" Associations to still further considerably reduce the "waste of energy" now prevailing.

If each Association were to inquire as to status, the size of contracts handled, the class of work which could be undertaken, and so forth, when individuals and firms were applying for admission, and record this, they could then draw up classifications of names of firms who were used to particular work, and who could take jobs up to certain limits.

As these Associations grow—and they undoubtedly will do so—applications would be made by consultants, city and chief engineers, business principals with work in view, and numerous other individuals, for lists of names of firms, &c., who could tackle certain contracts, and correct information would be given by the Association of people who *could* satisfactorily handle and complete such contracts.

If the Associations would do this, it would distinctly benefit their members by bringing grist to their respective mills, and not only so, but it would make the Associations a distinctive factor to be reckoned with, and at the same time they could help to save much of the now prevailing "waste of energy."

Will de Landon, A.I.E.E.

Sale, *January* 11*th*, 1904.

Electric Light Baths.

Can any member of your expert staff or other such reader of the Review give me information on the above subject? I understand that placing ordinary incandescent electric lamps in close proximity to the body has the effect of checking or curing certain microbic disorders; and, further, that by varying the shade or colour of the rays curative results can be obtained for troubles such as rheumatism, gout, lumbago, &c. I was told recently that His Majesty the King had used some form of treatment such as I outline above.

If reliable information can be obtained regarding the manipulation of the rays of light, and as to the temperature, &c., I think that electricians, even without the assistance of the physician, could be of some assistance to suffering friends by interesting themselves in "the bath that won't wash clothes."

C.

[The therapeutic value of the electric light bath appears to be well established, but we doubt whether it ought to be used except under expert medical advice.—Eds. E.R.]

Breakdowns in Electricity Works.

It would be interesting to know the make and size of storage battery Mr. Scott would suggest to take care of the load of a station, such as Bristol, for 24 hours, also the capital cost, including transforming gear, &c., the annual cost of upkeep, including losses of efficiency between the steam alternator and the distributing mains (the battery would have to be used whether wanted or not, to keep it in order), annual depreciation, interest and sinking fund. Supply station breakdowns are calamities, but when a man sends a suggestion to put us right, for heaven's sake let it be something financially practicable.

A. Hugh Seabrook,
Engineer and Manager.

Electricity Works, Barking.
January 11*th*, 1904.

While in no way attempting to minimise the harm that breakdowns do to the industry, I am greatly surprised that Mr. E. Kilburn Scott apparently knows so little about central station management (although I am aware he has had no experience of the same) as to suggest that it is the general practice for "electrical stations to go pottering along in the usual hand-to-mouth way."

The central station engineer fully recognises the importance of continuity of supply, and in many cases which I am familiar with takes all conceivable precautions against anything going wrong. There are, outside the circle of central station engineers, plenty of men who always imagine they could work and run a station "better than the powers that be"; and I am sure, if they were given a trial, in many

instances it would take a very long while to get up to the perfection that central station management has now attained.

I am constantly hearing of engineers who have given up the manufacturing work for central station life, and they are surprised and alarmed at the tremendous amount of work and thought required for the successful running of an electricity works. Before, they had been told "that anybody could run an electricity works," and I can only attribute this statement which one hears, to jealousy on the part of those that do not hold a chief's position. No man, who has had central station experience—certainly in high-tension work—would for one instant attempt to depreciate the amount of forethought, care and management required, and, therefore, I consider Mr. Scott makes a most unjustifiable accusation against central station engineers. It is absurd to compare the machinery required in a gas works, with that required in an electricity works!

Does Mr. Scott appreciate the fact that a small leak on any part of an electricity supply undertaking affects, to a certain extent, the whole system, whereas gas may go on leaking *ad. lib.*, without it making any difference to them at the gas works, or on their mains, nor does a fault occurring in a particular house cause any disturbance to the surrounding gas users.

Again, in the works, does Mr. Scott know there is practically no pressure to deal with in the gas retort? Can he compare it with high-pressure boilers? Does he appreciate that the successful central station engineer must be a man with good mechanical training, familiar with the working of all steam apparatus, such as that required by any good marine engineer? In addition thereto, that he must be a highly skilled electrical engineer, and that he is working his plant under absolutely the most trying and "accident causing" conditions, compared with the marine, water or any other kind of engineer.

Mr. Scott thinks that breakdowns should be entirely eliminated, but he is wrong in supposing that breakdowns do not occur, resulting in total extinction of gas in towns. I have known of several where the gas has entirely failed.

It is rather surprising, seeing that for some time Mr. Scott represented a well-known firm as their business manager, whose duty it was then to sell the manufactures of that firm, to find him blaming the Bristol engineer, because a certain firm's manufactures did not perform what they were supposed to do—as a fuse is sold for the purpose of acting as a fuse, and if it is the best procurable at that date, it is probably the fault of the manufacturer who designs and sells the fuse, rather than the engineer, who has to take the best he can get.

If manufacturers—and Mr. Scott represented them for some time—will endeavour to make their machines, switchboards, &c., in such a way that they will perform the duties required of them without breaking down, then I can assure Mr. Scott, the central station engineer's lot would be a happier one.

Again, Mr. Scott blames the engineers, or committees, for not having a tremendous lot of reserve plant. Does Mr. Scott appreciate the fact that the sole existence of electricity, as an illuminant, depends upon the way in which it can compete with its rival, "gas," and that to have a large amount of reserve plant means that the undertaking would not be required at all, because it would be impossible to compete with incandescent gas in price, owing to the heavy capital charges per unit sold then necessary. Personally, I think the Bristol engineer deserves the sympathy of all brother engineers, whether manufacturers or supply oles. It was an accident which no forethought could have prevented, and it was an accident, am glad to say, as rare, if not rarer, than explosions at gasworks.

Horace Boot,
Consulting and Resident Engineer.

Electricity Works, Tunbridge Wells,
January 11*th*, 1904.

In speaking of the "hand-to-mouth" policy of electrical engineers in not having sufficient reserve plant, Mr. Kilburn Scott quotes Bristol as an example. May I ask what spare plant or storage battery could avert such a breakdown? As was pointed out in these pages, the trouble at Bristol was due to the whole supply being controlled by one distribution board; hence, if absolute insurance against breakdown is necessary, this, too, should be duplicated. It is at the central station switchboard, and in the cable races to and from it, that a fire is most likely to originate: and these are generally the most dangerous and unget-atable places. The fact that it is little more than a year since a similar fire occurred at Croydon, causing total interruption of supply, emphasises the truth of these remarks. It is no good saying that these fires ought not to occur, for they do and will occur; and it is only by duplicating the switchboard that such occurrences can be absolutely safeguarded. The great expense and the comparative rarity of these fires is, of course, against such sweeping remedies; but one switchboard might be in two sections in different parts of the station, with bus-bars connected, thereby preventing a total shut down. If switchboards were duplicated, however, each board in turn could be made absolutely dead—at any rate, as far as the bus-bars are concerned—and repairs and alterations could then be done in perfect safety, and there would be no need for any further correspondence headed "Electric Shocks on Flat-Back Switchboards."

Mr. Kilburn Scott advocates the storage battery for emergencies; does he know of any central station possessing a battery that will supply the maximum load, or even half the maximum? I question whether any chief engineer would not rather take the risk of fire than give his assistants such a battery to keep in order.

I incline to think that the censure due on account of breakdowns should be heaped, not on the engineer, but on the electric light committee, who—I speak for the majority of cases—are generally the people to blame when a station is not fully equipped with plant.

J. B. F.

January 12*th*, 1904.

With reference to the failure on the H.T. switchboard at Bristol, as I was interested in carrying out the design of this switchboard and superintended the erection of the same, being also present when the board was put into commission, I think it is due to Messrs. Ferranti, Ltd., the contractors, that your readers' attention is called to the following points.

As far as I remember, the original switchboard, upon which the failure occurred, was designed and installed essentially as a machine board to control the alternators in the Temple Back station. Two spare machine panels of a much larger size were provided, *and machine-regulating gear was supplied for these.*

It would therefore seem that it was originally the intention to install further machines in the Temple Back station. This, however, was not done, and when the Avonbank station was completed these two spare machine panels on the Temple Back board were used for trunk main feeders to connect the two stations in parallel. Later on some of the smaller machines were disconnected from the Temple Back board, and their panels converted into trunk feeder panels to take further cables from Avonbank. It will thus be readily appreciated that the switchboard was ultimately put to a use which was not anticipated by the designers.

I am sure that if Messrs. Ferranti, Ltd., at the present time had to install a board for the existing conditions at Bristol, they would certainly advocate the use of automatic oil circuit-breakers, and eliminate fuses from the machine and trunk feeder panels altogether.

Bristol's unfortunate experience will serve the good purpose of bringing clearly before engineers the unsuitability of fuses for H.T. circuits. This question was recently brought forward by Mr. Eborall in his articles on switchgear which appeared in *Engineering*.

E. Garside.

Ferry Works, Thames Ditton,
January 11*th*, 1904.

Variable Speed Motors.

In Mr. Hobart's answer to my letter on the above subject, he did not altogether understand my remarks. If he will refer to it, he will see that the statement was made, "If the field

of a motor is weakened, brush shifting is necessary, not in order to use the reverse field, but in order to avoid the distorting field." In other words, if in a tramway motor part of the field is shunted, the motor will spark. This, of course, is not due to the fact that the effect of the reverse field is lost, because the brushes are in the geometrical neutral position. It is not usually due to increased self-induction on account of increased speed. The principal cause of the sparking is on account of the weak field. The fields have been distorted into the brushes. These last three sentences cover, I believe, all points of difference between us. If he can prove to me that I am mistaken, I would be glad.

In all other points we are in perfect agreement.

J. N. Dodd.

January 11th, 1904.

Superheated Steam.

It will be apparent to your readers that Mr. Booth's letter in your issue of 8th inst. is based on an entire misapprehension of our letter in the previous issue.

Dealing with independently-fired superheater furnaces, we pointed out that it was a most mistaken practice to admit surplus air *into* such furnaces, and so obtain a most wasteful and imperfect combustion, merely in order to reduce the ultimate temperature of gases reaching the superheater tubes.

We pointed out that with Erith's underfeed stoker the coal could be more economically burnt, and that the resulting small volume of gases at high temperature, say, 3,500° F., could very easily be reduced to, say, 1,200° F., *after* combustion was completed.

We agree with Mr. Booth that dilution *during* combustion might give a fuel efficiency as low as 35 per cent., but this was the very mistake we condemned. It is obvious that the conditions we attain, say, 3,500° furnace temperature, and 14 per cent. of CO_2 in furnace gases, represents a fuel efficiency of about 80 per cent.

The heat being thus economically raised from the minimum of fuel, we showed that it could easily be tempered from 3,500° down to 1,200°, after combustion was completed. Of course, if gases enter a superheater at 1,200°, and leave at 600°, only 50 per cent. of the heat can be utilised for superheating; hence the importance of starting with economical combustion.

Mr. Booth's own method is to burn much more coal than is needed for superheating alone, but to abstract the surplus heat after completing combustion, for a different purpose, viz., heating feed water; but when deducting the heat used for this latter object, the *identical* volume of gases at 1,200° would reach the superheater (assuming similar furnace efficiency), and the cost of superheating would be the same as in the method we indicated.

We have not the necessary experience to judge whether it is advantageous in practice to combine feed-water heating with superheating in these independently-fired furnaces; but wherever any furnace is used, for any purpose, the positive control of both fuel and air supply, and the resulting furnace efficiency, will make our stoker a desirable feature. In every case combustion should first be efficiently completed, and then (whether by dilution or by heat abstraction, as circumstances may warrant), the temperature can be reduced as desired without sacrifice of efficiency.

Erith Engineering Co.
CHARLES ERITH, *Manager.*

London, E.C., *January 12th*, 1904.

Packing for Export.

It has been suggested to us, as export packers, that placing a bag of lime in the same case with machinery when being packed for shipment would secure the arrival of these in better condition than is possible otherwise, owing to the lime's absorption of all moisture condensed in passing through the tropics.

It would be interesting to hear whether any other of your readers have tried this, and if so, with what success. It would, of course, only be of use in water-tight tin-lined cases, so as to absorb internal moisture. We should be glad to know whether it is thought that such moisture would make the lime at all dangerously hot.

Whilst on the question of export packing, it would be interesting to know whether it is the general custom of the trade for all packed machinery to be put in tin-lined cases.

Old Packers.

January 12th, 1904.

Design of Direct Current Machinery.

In looking over Mr. Val. A. Fynn's article on "The Design of Direct Current Machinery" in last week's issue, I noticed that he suggests Steinmetz' formula for H_a loss, as follows, viz. :—

$$\cdot 004 \times \text{cycles} \times (\text{lines per cm}^2)^2 \times \text{volume in cm}^3 \times 10^{-7}.$$

This, when worked out, comes to about 58 times more than Prof. Ewing's formula, viz. :—

$$H_a \text{ in watts} = \frac{\cdot 003 \times \sim \times B_a^{1\cdot 6} \times \text{volume in c. cm.}}{10^7}$$

Will Mr. Fynn, or some other gentleman, kindly explain this great difference?

A. B.

Series-Parallel v. Rheostatic Control.

In a certain town, not 100 miles away from Southport, there are running electric cars made by the Brush Co. and Dick, Kerr & Co., and working for the British Electric Traction Co. and the Corporation respectively. The cars made by the Brush Co. are double-decked, and came equipped with two 12-H.P. motors operated in series-parallel, and the cars made by Dick, Kerr & Co., are single-decked, and came equipped with two 25-H.P. motors, also operated in series-parallel.

After running a few weeks, the B.E.T. Co. removed one of the motors from some of the cars, and afterwards removed one from all the cars. Lately the Corporation have also removed one motor from the single-deck cars by Dick, Kerr and Co.

The only apparent difference in working is the loss of accelerating power and trouble on greasy rails; otherwise, when full speed is attained, there seems no difference at all.

The officials of the authorities in question claim that there is a great saving in working expenses, and I should like to have opinions from some of your readers on this subject if you can find me room in your valuable columns.

After the cars have once come equipped with two motors, the removal of one motor from the equipment will only strike out some of the standing charges, viz., part of the depreciation; the interest on the motor, lying useless, is still there. Possibly this is not taken into account.

H. J. Kitchen.

Hebden Bridge, *January 6th*, 1904.

The Chicago Theatre Fire.

We have read with interest your extract from the *Western Electrician*, giving particulars of the lighting of the ill-fated Iroquois Theatre. From the details given the amount of current used is by no means great, while the arrangement of lights and switches contains no novelty whatever. If the other devices in use in this theatre have been puffed up to the extent the electrical arrangements have, it must surely have been a very ordinary erection altogether. Indeed, we should be ashamed to think that the first theatre switchboard we ever designed would not do all that is credited to the Iroquois board, and we venture to say that no theatre engineer or manager in this country would be satisfied with a less powerful or a less flexible arrangement of lights than that given in your extract from the American Press.

Edwards & Shaw.

Birmingham, *January 8th*, 1904.

Steam Turbo-Generating Plant.

As stated at the end of his last communication, our managing director, Mr. Morcom, is at present out of England, but even if he had been at home we are sure that he would not wish to occupy more of your valuable space in

carrying on the discussion on present lines. We are quite satisfied to leave the matter in the hands of your readers on what has been already said.

For **Belliss & Morcom, Ltd.,**
Geo. B. Parrott, *Secretary.*

Birmingham, *January 11th*, 1904.

In my letter of January 4th, I am sorry to find that when copying the MS., the typist omitted Shipley from the list of turbine stations with its coal cost of ·37d.; the average figure is correct with this included. The next average should read ·68d., and not ·643d.

John H. Barker.

Loughborough, *January 13th*, 1904.

May I be allowed to point out an error in your correspondent Mr. J. H. Barker's arithmetic? The average of the steam turbine stations he gives, works out to ·795d. per unit for fuel, and not ·747d. The turbine stations are, therefore, $7\frac{3}{4}$ per cent. worse than the reciprocating engine stations, instead of 1·2 per cent. only. At the same time I do not attach any great importance to statistics of this sort.

The results achieved with the steam turbine at the Newcastle-on-Tyne Supply Station may be good, but from the diagram "A Student" sends, it is obvious that if reciprocating engines had been used, the results would have been materially better.

Again, although Mr. Barker does not happen to have access to Mr. Emmett's paper on recent steam turbine developments, he is quite prepared all the same to state what that gentleman "did say," or "intended to say," and proceeds to give what he would have liked him to say. What Mr. Emmett actually said is as follows:—

In turbines which we have tested the steam consumption has been reduced from 6 to 7 per cent. for every additional inch of vacuum above 25 in. Such a reduction is, of course, very important, and justifies large expenditures upon condensing apparatus.

Mr. Barker would have it that the figure is 2 per cent. only, but the statement that the Parsons turbine gained 4 per cent. on the steam consumption for every inch of vacuum above 25 in. has so often appeared in print that many, like myself, must have come to think that it was part of the accepted "gospel" of the steam turbine. It appears now that it is all wrong, and that Mr. Barker has the authority of the makers for saying so. It makes one wonder whether any of the other information concerning the steam turbine is of a similarly unreliable character. No doubt engineers of supply stations are getting rather tired of being reminded that if they expect to get the test-house result from their turbines they must maintain the same high degree of vacuum. They will be finding, too, in some cases, that to throw about double the quantity of circulating water required for a reciprocating engine over a 40-ft. cooling tower is an expensive proceeding.

Another article of the steam turbine faith is that turbines are not injuriously affected by superheat. This statement has been made over and over again; it was an undoubted fact according to one correspondent, but when evidence was brought forward to the contrary, it transpired that turbines about the country were being fitted with new blades of special metal in the endeavour to make them work satisfactorily with superheated steam. The fact is that the steam turbine is no more immune against the effects of superheat than your old friend, the

Reciprocating Engine.

January 12th, 1904.

The Shifts of a Shift Engineer.

[We have received a lengthy communication from a correspondent on the above subject, from which we make the following extracts.—Eds. E.R.]

Judging from the present state of things as regards salaries, I consider your correspondent under the above heading to be very lucky to have 18s. or £1 a week to pay with, and that 2s. is more on an average with the salaries now paid for the most responsible position of shift engineer. To confirm what I have just said, I think the writer would be surprised to know that there are *gentlemen* in his capacity receiving the enormous salary of 15s. per week for their valuable services, and in addition they act as chief clerks, and get up at the early hour of 4 a.m. to commence their shift, working 10 hours a shift. For reference, I will give some idea of the salaries on an average of stations I have come in contact with:—

Chief	£5 per week.
Chief assistant, from	£1 to £2 5s. per week.
Fitter or fitter driver	36s. to £2 "
Under driver	30s. to 33s. "
Stokers average	26s. to 28s. "
Labourer and cleaner	21s. to 23s. "
Jointer	£2.
Switchboard attendant	5s. to £1, and jolly lucky to have anything.
Shift engineer, from	15s. to 25s. per week.

I think it would be better to be a labourer and work convenient and regular hours. Just fancy anybody taking orders from a 15s. a week man. Nevertheless it is a true everyday fact.

I will give what I consider the chief cause for such things: they are gentlemen's sons, who have not the moral courage to demand a reasonable salary for their services.

If necessary, the writer can say a lot with regard to Faraday House men in connection with the above.

I should like to have a word with regard to the accident at Cardiff, which, in the writer's opinion, was only to be expected sooner or later. We may put the matter on the salary scale, and consider what amount of destruction lies at the hand of, say, the switchboard attendant, who is paid on the average less money than an outside labourer. In conclusion, I hope that this issue of your paper will come more into contact with the town ratepayer or councillor on electricity committees, and not into the hands of the, in most cases, bigoted chief engineer, who is only too anxious as to his own salary.

Disgusted.

BUSINESS NOTES.

Electrical Wares Exported.

Week ending Jan. 13th, 1903.		Week ending Jan. 12th, 1904.	
Alexandria	Value £23	Alexandria	Value £27
Auckland	180	Amsterdam	40
Beira	34	Bombay	86
Bombay	92	Brisbane	361
Bremen	75	Buenos Ayres. Teleg. mat. ..	148
Buenos Ayres. Teleg. cable ..	550	Calcutta	298
" Teleg. mat. ..	40	" Teleg. mat. ..	243
Calcutta	599	Cape Town	321
" Teleg. cable	170	Channel Islands	69
Canada, *via* U.S.	19	Christiania. Teleg. apparatus. .	132
" Teleg. cable	52	Colombo	179
Cape Town	1,293	Demerara	96
Christiania. Teleg. wire ..	26	Durban	2,437
Durban	927	" Teleg. plant	1,905
" Teleg. mat.	98	East London	818
Fremantle	544	" Teleg. mat.	22
Gibraltar	30	Gibraltar	199
Halifax	11	" Teleg. mat. ..	70
Hamburg	113	Gothenburg	21
Liban	29	Hong Kong	368
Madras	28	Malta. Elec. machinery ..	135
Melbourne	177	Melbourne	129
Nagasaki. Teleg. mat. ..	1,680	Paris	136
New York	85	Perth	197
Ostend	70	St. Lucia	28
Otago	530	Shanghai	84
Port Elizabeth	1,260	Stockholm. Teleg. wire ..	37
Rockhampton	46	Sydney	889
Rotterdam	38	Valparaiso	59
Sekondi	63	Zanzibar. Teleg. mat.	59
Shanghai	184		
Sydney	31		
Valparaiso	30		
Total ..	£9,127	Total ..	£9,588

Foreign Goods Transhipped.

Halifax. Elec. carbons	Value £26	Gothenburg. Elec. appar.	Value £105
Singapore. Telephones ..	24		
Sydney. Electric light apparatus	195		
Total	£245	Total	£105

The Telegraph Wire Export Trade.—The year 1903 closed, as it started, with a very quiet tone in the export trade of this country in telegraph wire and apparatus connected therewith. The shipments last month only amounted to £43,237, as compared with £145,271 in November last and £106,591 in December, 1902. The fluctuating character of the trade is shown by the fact that the

minimum monthly shipments during the past year were as low as £19,676, while the maximum was £145,271. The aggregate exports during 1903 only reached a total of £1,808,136, as contrasted with £2,838,641 in the preceding 12 months, and £3,147,983 in 1901.

United States Electrical Exports.—The following is a list extracted from a report drawn up by Mr. Seymour Bell regarding manufactured goods sent to the United Kingdom and British possessions during the years ending June 30th, 1901 and 1903, for which we are indebted to the *Board of Trade Journal*:—

Electrical Machinery.

	1901.	1903.
British North America	807,419	1,240,900
West Indies and Bermuda	26,349	51,799
British East Indies	317,081	25,622
British Australasia	169,539	200,469
British Africa	34,843	122,434
Hong Kong	11,873	18,808
Total exported to British possessions ..	1,367,104	1,660,032
Percentage of total United States exports	23·5	28·7
Total exported to United Kingdom ..	2,760,733	2,256,062
Percentage of total United States exports	47·5	39·0
Total exports from United States	5,812,715	5,779,459

Laminated Brush Switches of Large Current Capacities.—The extensive and rapidly increasing use of heavy current distribution systems has necessitated several radical changes in the designs of switches. For opening circuits of considerable current value the old type of switch, though quite satisfactory for use on circuits carrying small currents, is out of the question, owing to it being extremely difficult to operate on account of the great physical effort required to break the circuit. To meet this difficulty, the British Thomson-Houston Co., Ltd., have introduced a laminated brush lever switch, which is noteworthy for the great facility with which it controls circuits of large current capacity.

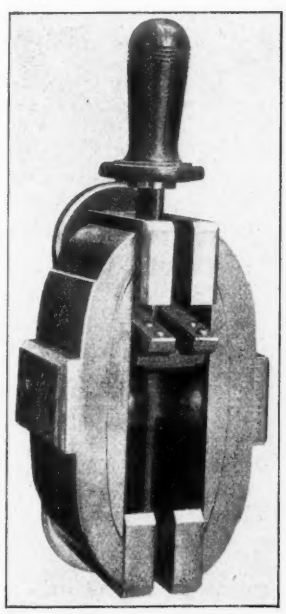
This switch is especially serviceable for use with heavy currents at moderate potentials, and is constructed for operation on 125 or 250-volt circuits, in capacities ranging from 1,200 to 4,000 amperes. It is so designed that, however large its current capacity, it can be opened and closed with very little physical effort, and without the sacrifice of a firm and positive contact. The blade elements are of laminated brush construction, ensuring, under suitable tension, an even and complete contact over the entire contact area. The switch is provided with a secondary contact, on which the circuit is broken, thus preventing injury to the brushes due to arcing. The laminations or brushes are of rolled copper bound together by thicker outside spring bars and by a gun-metal block on the inside of the lamination, the whole structure of each brush being fastened together by steel clamps. The contact part of the stud is squared on the base of the board to make contact with the brushes.

For use in connection with still heavier currents and at higher potentials, the British Thomson-Houston Co., Ltd., have also introduced a laminated brush toggle switch. This switch is suitable for operation on circuits up to 600 volts in capacities ranging from 2,000 to 10,000 amperes, and, like the laminated lever switch, its movable contact parts are laminated copper brushes. The form of construction adopted enables the opening and closing of the switch to be accomplished with the greatest ease.

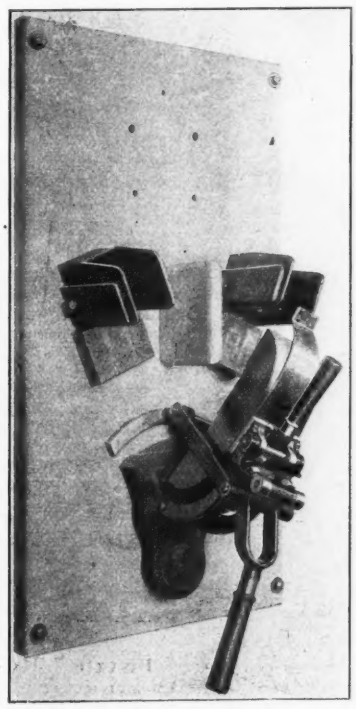
The toggle form of mechanism which is used to operate the movable element not only secures ease of operation, but makes the final contact under heavy pressure, securing the most positive electrical connection. This switch is provided with a secondary contact on which the circuit is always broken, thus protecting the main contacts from any injury due to arcing. Unless specially constructed for alternating current service, it is provided with a magnetic blow-out for the secondary breaks. The brush is of laminated rolled copper supported between an inner block, and the outer lamination of spring bars, as in the case of the laminated lever switch. The supporting and actuating mechanism of this switch is of wrought-iron or steel, enamelled black, while the handles are of hard wood, stained black and polished.

Safety Counterweight Set.—Messrs. Schmahl and Schultz, of Barmen, whose English agents are Messrs. Plutte, Scheele & Co., 18 and 19, Queenhithe, London, E.C., are supplying a new counterweight (No. 173), which leaves the ceiling rose entirely free from any strain, such being borne by the back plate which is screwed to the wood block under the china base. It is a weakness of many counterweight pendants that the whole weight has to be borne by the ceiling rose cover, which, with a heavy fitting, may result in the china thread breaking, and the fitting being damaged.

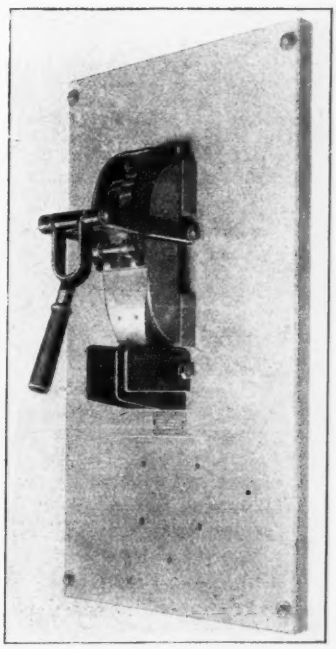
Forthcoming Books.—Messrs. Archibald Constable and Co. will publish during this month Mr. James Swinburne's book on "Entropy." They will also publish at the same time a new illustrated work by Mr. F. Goodrich, entitled "Refuse Disposal and Power Production." This book deals with the practical and economical use of town refuse for the production of steam power, and will appeal to local authorities and central station engineers.



3,000-Amp. 250-Volt Laminated Lever Switch.



8,000-Amp. Single-Pole Brush Toggle Switch.



8,000-Amp. Double-Throw Brush Toggle Switch.

B.T.H. Laminated Brush Switches of Large Current Capacities.

Newcastle and District Association of Electrical Contractors.—On 8th inst. a dinner was given by the members of this Association to the delegates from the different towns in the North of England who were attending the meeting of the Northern Section of the National Electrical Contractors' Association on the following day, Saturday. The President of the National Association (Mr. Rawlings), and the President of the London Association (Mr. Berry) journeyed down specially from London. Mr. Cross (Falconar, Cross & Co.) presided, and about 20 covers were laid. The others present were Mr. Wallis, of Leeds, Messrs. McDermott & Steinthal, of Manchester, Messrs. Sutton & Harford, of Liverpool, Mr. Tattersall, of Middlesbrough, Mr. Andrews, of Sunderland, Mr. Shaw, of Stockport, Mr. Armstrong, of Carlisle, Messrs. T. G. Usher (vice-chairman), Gowdy, Andrews, Coleman, Beilby, C. Usher, and R. Robson (hon. secretary), of Newcastle. After the usual loyal toasts, the "National Association" was proposed by the chairman and replied to by Mr. Rawlings. Mr. Usher, the vice-chairman, proposed the "Northern Section," to which Mr. Wallis, the chairman of that section, replied. The "Newcastle Association" was proposed by Mr. Berry, Mr. Robson replying; "Our Guests," by Mr. Andrews, Mr. McDermott replying. The health of the chairman was also proposed and responded to. Several songs were rendered by members.

Book Notices.—"The Half-Tone Process," by Julius Verfasser. London: Iliffe & Sons, Ltd. 5s. net.

"Elektro-Akustische Untersuchungen," by R. Hartmann-Kempf. Frankfort-on-Main: Gebrüder Knauer.

"Willing's Press Guide for 1904." London: James Willing, Jun., Ltd. 1s.

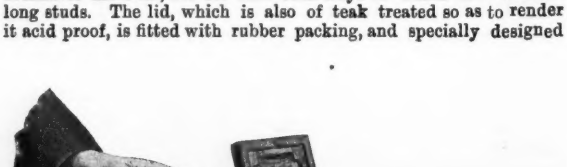
"The Locomotive Simply Explained," by Charles S. Lake, London: Percival Marshall & Co. 6d. net.

"Mathieson's Highest and Lowest Prices—1904." London: Mathieson & Sons. 2s. 6d.

Lockwood's Price Book for Builders and Contractors, 1904. Edited by F. T. W. Miller. London: Crosby Lockwood & Co. Price 4s. The distinguishing features of this work are too well known to require detailed reference. The electric lighting section has been revised and extended, the editor being indebted to Mr. A. P. Haslam in this respect. Prices are given of some of the leading electrical manufacturers' products, and estimates for wiring houses for electric light and bells. The City of London Co.'s general conditions of supply are given, but instead of the I.E.E. wiring rules, those of the Phœnix Fire Office are used.

Geometry for Technical Students. By E. H. Sprague. London: Crosby Lockwood & Son. 1904. Price 1s. net. In this work the author adopts the modern treatment of his subject, departing wholly from the Euclidean sequence. The figures are clear, and very many of the propositions are illuminated by the addition of examples of their practical application. A number of problems in plane geometry which are found useful in drawing are appended. The book is admirably adapted for teaching purposes.

An Improved Type of Ignition Battery.—Owing to the vibration to which ignition batteries for motor-cars, &c., are subjected, and the consequent falling out of material, short-circuits are frequently caused, which, although trifling in themselves, are sufficient to put the battery out of order. The use of transparent cells has enabled this to be readily detected, but owing to the fact that they are sealed in, this does not help the unskilled user, as although he may see what is the matter, he is unable to get at the cause. In many cases washing out the cells and elements is all that is necessary to retore the battery to perfect condition, and most of the expense is incurred in unsealing and resealing the cells. We have recently been shown an improved type of "Umpire" battery which is being put on the market by Messrs. Sutherland and Marcuson, of Montpelier Works, Twickenham, and 61, Chandos Street, Strand, in which this difficulty has been cleverly overcome. The illustration herewith, which is from a photograph of two ignition batteries of 60 ampere-hours at ignition rates, shows the advantages at a glance. The cells, which are of practically unbreakable material, are set into teak trays to which are attached long studs. The lid, which is also of teak treated so as to render it acid proof, is fitted with rubber packing, and specially designed



New "Umpire" Batteries.

rubber collars are fitted to the lugs, which pass through holes in the lids. When the lid is screwed down by means of the fly nuts shown in the illustration, it forms a perfectly tight arrangement, and if the vent holes in the lid are plugged, the battery may be allowed to stand upside down. It is evident that any practical man can take off the lid, remove the elements, wash them and the cells, replace them, refill the cells, and screw on the lid in less time than it takes to describe them. The makers inform us that they have made the following tests with a two-cell battery of this description. It was standing upside down fully charged when the time was taken, it was reversed, the lid unscrewed, the elements removed and washed, the cells emptied and washed, the elements replaced, fresh electrolyte poured in, the lid screwed down tight and the battery again turned upside down, the whole operation being done by their man in exactly two minutes. The elements are of the well-known "Umpire" type with porous plates and rubber bands. There should be a large demand for this type, which the makers call their "Accessible Skeleton Type" for use in motor-cars and wherever, owing to rough treatment, small defects are liable to occur.

National Electrical Contractors' Association (Northern Section).—Successful meetings of this Association were held at the Metropole Hotel, Newcastle-on-Tyne, on Saturday, January 9th, under the chairmanship of Mr. E. C. Wallis, of Leeds, supported by Mr. Rawlings, of London, the President of the N.E.C.A. Many points of importance to the electrical trade were discussed, and it was felt that the Association was in a satisfactory condition and doing good work. A model specification is being drawn up, and a system of registration of workmen is in use, and is found to be very useful to the members; many other matters of interest are also being brought forward by members of the Association.

Metallic Packings.—Messrs. Newton & Nicholson, of the Tyne Dock Corrugated Packing Works, South Shields, have sent us some specimens of their metallic packing (Taylor's patent), such as they have supplied to a large number of engineering and ship-repairing firms in all parts of the United Kingdom, and also to some electric lighting works. The Taylor packing consists of metal rings, oblongs, and squares, cut from very thin sheets of brass, and corrugated, and it is placed in the joints (with cement) in joining together metal pipes, &c., joints being thus made steam and water-tight with certainty and durability. One corrugated ring is laid along with the cement on the inner part of the surface of the flange, clear of the bolts, and in screwing up the joint, the ridges of the corrugations yielding to it, it is claimed that it will take the impressions off all the irregularities of the surfaces of the flanges, thus making it impossible for any ordinary high pressure from either steam or water to penetrate the joint.

Trade Announcements.—Messrs. W. H. Bailey & Co., Ltd., Salford, Manchester, have secured a license from Mr. E. W. Köster, of the firm of Messrs. Pokorny & Wittekind, Frankfort, for the sole right to manufacture in the United Kingdom his patent positive valve air compressors and vacuum pumps, which were awarded a gold medal at the recent Düsseldorf Exhibition.

Mr. F. S. Letts, of Derby Road, Northampton, has gone into partnership with Messrs. F. T. & A. Garrett, of 23, Mount Street, and business will be carried on as F. T. & A. Garrett, Letts and Co., electric light and power engineers, at 23, Mount Street, Northampton.

Messrs. L. M. Ericsson & Co, Ltd., have handed over the whole of their business in Great Britain and Ireland, and in a number of the British colonies and dependencies, to an English company called the "British L. M. Ericsson Manufacturing Co., Ltd.," with works at Beeston, near Nottingham, where they will manufacture the well-known Ericsson specialities in telephone instruments and switchboards. The new company wish it to be understood that they have no connection whatever with any other firms trading under somewhat similar names, and that neither they nor Messrs. L. M. Ericsson & Co., of Stockholm, supply such firms with goods; so that all communications should be addressed to them direct, or to the agents which they may appoint.

Messrs. Moul & Co., electrical engineers, 76-78, York Street, Westminster, S.W., announce that they have taken over the electrical departments of the firm of O. Berend & Co. (in liquidation) from the Receiver and manager, and are carrying on the business at the address mentioned. All orders placed with the Receiver and manager will be executed by them.

Mr. Edward Till has retired from the business of Edward Till and Co. owing to advancing years. The business will be continued as hitherto by Messrs. Geoffrey Hoare and Charles Bower, assisted by Mr. W. S. T. Worthington.

The Engineering, Building and Allied Trades Depôt was opened at 12, Bank Street, Manchester, on Wednesday, 13th inst. Its object is to afford firms the advantage of having a central town office and showrooms, and change their exhibits whenever they please. A staff is also provided to push the sale of special lines exhibited. Those who wish for fuller particulars can obtain circulars from the manager, Mr. A. Tolhausen, at the above address.

Private Bills in Parliament.—On Saturday the first batch of memorials alleging non-compliance with Standing Orders in the case of the private Bills coming before Parliament next session, were deposited in the Private Bill Office. Amongst the Bills affected were the following:—

London United Tramways.—The Middlesex County Council, who are the road authority for the district in which it is proposed to construct certain tramways, allege that their local assent as the authority has not been obtained.

London United Tramways (Railways).—The London County Council allege that the suggested railways at Hammersmith are not railways according to the true intent and meaning of the Standing Orders, but are tramways, and that the necessary notices in the case of tramways have not been given.

Llanelly Tramways.—The British Insulated and Helsby Cables, Ltd., state that the effect of Clause 5 of this Bill, which is promoted by the Urban District Council, is to empower the memorialists to make and maintain the works which were authorised by the Llanelly and District Light Railway Order, 1902, and which were conferred upon the Llanelly and District Electric Light and Traction Co., Ltd. They allege that the notices do not, as required by the Standing Orders, contain a description of the termini of the proposed works, nor does the Bill specify the gauge of the proposed tramways.

North Wales Electric Power Bill.—In his memorial, Sir Richard H. Williams Bulkeley complains that the plans deposited are erroneous and defective, and do not show properly the whole of the work proposed to be carried out by the Bill.

London County Council Tramways.—There are two memorials against this Bill, one by the Borough of Holborn and one by Messrs. Maple & Co. and Messrs. Shoolbred. Both allege that the necessary consent of the road authority has not been obtained.

Leeds Corporation (Consolidation).—The West Riding County Council and the Yorkshire Electric Power Co. have deposited memorials against this Bill. The Yorkshire Electric Power Co. state that by Clause 111 of the Bill it is proposed that from and after the passing of the Bill no person shall place any electric line along, over or across any street within the city, without the consent in writing of the Corporation, and that the Corporation may require any person who shall so place any electric wire to remove it. It is stated that the necessary notices as to this power were not published, and, moreover, the effect of the clause is to alter the provisions of the Yorkshire Electric Power Act of 1901, whereby that company is empowered to lay mains through the city except within a defined area. In respect of this, no notice to the company has been given.

Catalogues and Calendars.—A useful diary has been issued by the BRITISH STEAM SPECIALITIES, LTD., of Fleet Street, Leicester. It has separate sections for engagement entries, monthly cash accounts, and general memoranda. A good deal of engineering data and particulars of the company's manufactures are given.

An arc lamp calendar has come to hand from MESSRS. CROMPTON AND CO., LTD. Each monthly card has a view of some place where the Crompton arc lamps are in service. A complete calendar for 1905 is given at the end.

The GENERAL ELECTRIC CO.'s progress sheet for January shows their fuseboards, plug adaptors, aerial cables, and a number of other specialities, the prices of some of which have been reduced.

We have received from MESSRS. ERNEST SCOTT & MOUNTAIN, LTD., of Newcastle-on-Tyne, copies of several new illustrated circulars relating to their electrical machinery. No. 52 is a collection of views of engines and generators, and some other electrical machines which they have supplied to municipalities and engineering workshops, shipyards, collieries, and so on for central power station equipments. No. 53 contains numerous pictures of cranes, winches, pumps, pig-breakers, fans and other motor-driven machinery supplied to iron and steel works, shipyards, factories, &c. In circular No. 54 is an excellent collection of views of electrical mining machinery, including pumps, haulage gear, locomotives, capstans, coal-cutters, switches, &c. All of the lists are well set out and admirably illustrated.

MR. J. C. STEWART, of Donegall Quay, Belfast, has placed before us several circulars respecting his steam specialities, including the "Unique" reducing valve, also spiral and other protectors for gauge glasses.

The Scottish Mining Fatality: A Claim.—In the Glasgow Court of Sessions last week the record was closed and issues ordered by Lord Kincairney in an action by Daniel Scullion, Derryadd, Lurgan, Co. Armagh, against Robert Addie & Sons' Collieries, Ltd., mine owners, Glasgow, for £500 damages for the death of pursuer's son, James Scullion, who was employed in defenders' Shawhead pit at Coatbridge. On September 11th last deceased, along with his cousin John Scullion and Robert Bell, all miners, were journeying along the main road of the pit when pursuer's son and Bell fell to the ground, and were subsequently found to be dead, the cause being electric shock. Pursuer explains that the pit was fitted with electrical appliances for pumping and for signalling operations. For pumping operations electricity was generated by a dynamo at the pithead and conveyed in three cables down the shaft, where they were, not insulated, and along the roads, where they were. The voltage on these cables was extremely high. Electricity for signalling purposes was generated in a battery at the pithead. The voltage on the signalling wires was small, and there was no danger in touching them, and they were not insulated. It is believed that the cause of the accident was that the power cables and signalling wires came into contact in the shaft, and that the latter thus became charged with a high voltage, which proved fatal to Scullion and Bell, who are believed to have accidentally touched the signalling wires. Pursuer says the cables in the shaft should have been insulated and placed further apart from the signalling wires to prevent the electricity escaping to the wires. Defenders deny that there was contact in the shaft. The wires and cables, they say, are fixed at points distant from each other about 35 ft. They explain that the electrical system in use is the customary and the usual method employed in coal pits.—*Glasgow Evening Times.*

Dissolutions and Liquidations.—The City and Suburban Electric Carriage Co. (1903), is winding up voluntarily, with Mr. W. B. Peat, 3, Lothbury, E.C., as liquidator, Creditors are to send particulars of debts, &c., to Mr. Peat by February 17th.

Creditors of Mercier's Patents, Ltd., are to send particulars of debts, &c., to Mr. M. Mercier, 252, Chapel Street, Salford, the liquidator, by February 7th.

A meeting of the North-Eastern Telephone Co. is to be held at Gateshead on February 11th to hear an account of the liquidation proceedings from Mr. C. Humble, the liquidator.

Messrs. J. H. Bartlett and D. H. Ogden (Perry & Co., electricians, of Grafton Street and Avery Row, London) have dissolved partnership.

Messrs. G. R. and J. Marson and H. W. Burbury (Marson Bros. and Burbury, gas and electrical engineers, Coventry) have dissolved partnership. Mr. G. R. Marson attends to debts, &c.

A meeting of Howell's Simplex Anti-Inductive Telephone Syndicate is to be held at 33, St. Swithin's Lane, E.C., on February 19th, to hear an account of the winding up from the liquidator, Mr. D. F. Basden.

Colonial Wood-working Machinery.—The British Westinghouse Co. are supplying—through Messrs. John Petrie, Son & Co.—a number of motors for driving an extensive wood-working plant at Christchurch, New Zealand. The motors are of the company's new "SB" direct-current enclosed type, and are direct-coupled to the various machines.

Plant for Sale.—The Halifax Corporation is inviting tenders for the purchase of two Lancashire boilers and one Pollit and Wigzell engine which are not required now that alterations are being made in the electricity works. See our advertisement pages to-day.

The Corporation of Launceston, Tasmania, are inviting offers for five 100-KW. water-driven turbo-alternator sets (Gilkes-Siemens), switchboards, Siemens direct-current arc lighting machines, &c., as detailed in our advertisement pages to-day.

Reduction of Capital.—On Tuesday Mr. Justice Buckley sanctioned the petition of the Thomas Lighting Co., Ltd., for the reduction of its capital from £15,000 to £5,000. The company, says a financial daily, was formed to work patents for the substitution of electricity for gas in the lighting of railway carriages, and has lost the difference between the above sums.

LIGHTING AND POWER NOTES.

Andover.—In consequence of the threatened opposition of the T.C., the Southern District Electricity Corporation has decided not to proceed with its application to the B. of T. for powers to carry out the proposed scheme for lighting the borough.

Armagh.—The County Council has resolved to offer no objection to the Ulster Electric Bill.

Baku.—An electric power station has recently been erected to supply energy for the working of about 2,000 petroleum wells in the district. The plant installed comprises four tubular boilers, fitted with superheaters, two horizontal triple-expansion engines, each connected to a 700-KW. alternator working at 5,600 volts. Three sub-stations have been erected on the oil fields, and transform down to a 1,000-volt supply. The majority of the motors at work are of 40 H.P.

Bo'ness.—Terms have now been arranged with the National Electric Construction Co. for supplying the burgh with electricity. The company has offered, by way of compromise, to reduce its price for fitting up the installation, by £500, plus the premium thereon—in all, £535. Messrs. Burstall & Monkhouse, the consulting engineers, have informed the Council that the actual cost of the works to the contractors had now been reduced to £20,287. In view of the company's abatement of £535, the T.C. accepted the offer. It was further agreed to borrow £25,000 to carry out the scheme.

Bristol.—The L.G.B. has sanctioned the borrowing of £10,000 for free-wiring purposes.

Caerphilly.—The U.D.C. on January 7th resolved to apply for a prov. order for E.L., the area to include Caerphilly, Llanbradach, Senghenydd and Aber. The estimated cost of the scheme is £5,500.

Cannock.—The U.D.C., which is negotiating with Messrs. Whittaker Bros., Ltd., of Dudley, for the lighting of the district by electricity, has resolved that the Hednesford compulsory area clause shall not be insisted upon if counsel otherwise approves of the prov. order.

Canterbury.—The T.C. has adopted the following charges for private lighting:—On the maximum demand system, 7d. and 2d. per unit, and on the flat rate 5d. per unit. Extra discounts are to be allowed for power.

Clevedon.—The Western Electric Distributing Co. has received the assent of the T.C. in regard to the lighting of its area by electricity.

Crediton.—The U.D.C. has replied to Messrs. Christy and Co. that it will raise no objection to the prov. order they intend applying for to supply the town with electric light, providing they agree to certain conditions.

Derby.—The T.C. has resolved to expend £1,250 upon a scheme for lighting the electric tramway routes by attaching lamps to the tramway standards.

Dewsbury.—Certain charges have been made to the effect that the borough electrical engineer, Mr. R. H. Campion, had been receiving a commission of 10s. per barrel of oil supplied to the electricity works. After careful investigation the Electricity Committee has come to the conclusion that the charges are without foundation, and it passed a resolution approving of Mr. Campion taking legal proceedings against the person making the charges.

Dursley.—The R.D.C. has decided to assent to the application of the Gloucestershire Electric Power Co. for a prov. order for E.L.

Ealing.—The T.C. has decided to apply to the L.G.B. for a loan to purchase four acres of land for the Corporation electrical department at West Ealing, the G.W. Railway Co. having agreed to sell to the Council the required land at £700 per acre.

Edmonton.—At a meeting held on the 11th inst., the D.C. adopted the electric lighting scheme of Mr. R. Hammond, estimated to cost £44,000. The Council had a second scheme before it prepared by Mr. W. C. C. Hawtayne, which was estimated to involve an expenditure of £33,000. The proposals of both experts showed a small weekly profit.

Gainsborough.—The U.D.C. has been advised by its engineer to safeguard its interests by opposing the Bill of the Lincolnshire and Yorkshire Electric Power Co.

Gateshead.—The T.C. has adopted the proposal of the Durham County Electrical Power Distribution Co., for a conditional reduction of prices to consumers, on the understanding that the period of 13 years under the prov. order be extended to 14 years, but not 19, as suggested by the company.

Grantham.—The T.C. has decided not to oppose the Bill of the Lincolnshire and Yorkshire Electric Power Co., which seeks powers to supply energy in bulk and also for power, provided overhead wires are not used.

Halifax.—The T.C. last week resolved to apply to the L.G.B. for sanction to borrow £10,000 for the extension of the electricity undertaking, as follows:—

One 700-kw. steam dynamo and accessories	£7,950
Switchboard, &c.	420
Cable and connections	220
Meters	1,000
Contingencies	410
	£10,000

Horwich.—Owing to a number of applications having been received for a supply of electricity by the Bolton T.C., the latter body has approached the U.D.C. on the question of supplying energy in bulk. The U.D.C., however, favours the idea of a prov. order being obtained, and a committee has been appointed to consider the question.

Kinghorn.—The inhabitants of the burgh are considering a proposal by the Fife Electric Power Co. to erect a generating station between Kinghorn and Inverkeithing for the purpose of lighting the district and a number of the adjacent towns.

Knutsford.—The U.D.C. has decided to apply to the B. of T. for a year's extension of time in connection with the E.L. order, with a view to the order being leased to a company.

Leek.—The U.D.C. has decided to supply energy for power purposes at 1½d. per unit on a guaranteed consumption of 225,000 units per annum for three years.

London.—Marylebone.—At a meeting held on the 7th inst. the Mayor stated that a Committee of the T.C. had interviewed the directors of the Metropolitan Electric Supply Co. twice, to ascertain the terms and conditions on which the company would agree to set aside the arbitration award of £1,212,000 required to pay for the company's local property. The directors declined to set aside the award unless they received in some form an equivalent for the amount awarded. The company has made certain suggestions to facilitate the completion of the purchase, viz., that the company should accept stock having a prior charge upon the revenues and rates of the borough and bearing interest as agreed, the Council to redeem the stock at par in 42 years; the annual rent to be paid by the company to be a fixed sum practically equivalent to the yearly interest on the stock. Other proposals were as regards the capital to be provided by the Council in respect of the period from January 1st, 1902, until the commencement of the lease. The Council will hold a special meeting to receive a report of the Electricity Committee concerning these proposals.

The terms of the compromise suggested by the Metropolitan Electric Supply Co. have been regarded as very unsatisfactory, and a meeting of the ratepayers has been convened for the 19th inst. to discuss the advisability of proceeding with the Bill deposited in Parliament.

Brompton and Kensington.—This company has made a reduction in the price of energy for lighting, which varies from 5½d. per unit under 500 units to 4d. under 5,000 units. The charge for power will remain at 3d., and discounts will be abolished.

Battersea.—The E.L. Committee of the B.C. reported on 11th inst., that it had a communication from the electrical engineer suggesting the advisability of increasing the plant at the generating station to cope with the demand which will probably be made in the winter of 1904-5, by the provision of the following:—750-kw. turbine and generator, condenser, two water-tube boilers with mechanical stokers and accessories. The Committee resolved that Messrs. Kennedy & Jenkin be instructed to prepare the necessary plans for the extensions upon the usual terms. The estimated cost is £11,000.

Metropolitan Asylums Board.—At the meeting of the Board last week, it was agreed, on the recommendation of the Finance Committee, to make application to the L.G.B. for an order authorising the expenditure of £4,350 on the extension of the electrical plant of the Grove Hospital, and the wiring of the Fountain Hospital. The work at the Grove Hospital is estimated to cost £1,136, and that at the Fountain Hospital £2,792.

Southwark.—A hitch has occurred as to the municipal electric lighting undertaking. The prov. order was taken out by the parish of Newington prior to its incorporation with the other districts which now form part of the Borough of Southwark. Last year there was a deficiency of £795 on the electric lighting, and the district auditor held, his decision being subsequently confirmed by the L.G.B., that this sum should be chargeable only to the parish of Newington. At the last meeting of the B.C. it was announced that application had been made to issue a scheme making the expenses of the undertaking chargeable to the whole borough.

Johannesburg.—A serious fire broke out a few weeks ago at the electric light station, which completely destroyed the single-phase plant and equipment. The station consists of two rooms, one containing the three-phase plant, which was not damaged, while in the other was installed the single-phase alternating plant, consisting of eight machines. These generators, which were used for lighting, were shut down at midnight, and the room locked up, everything being inspected by the watchman on duty. At about 1.50 a.m. the fire occurred, and after shutting off all the supply, the Fire Brigade was called out, the conflagration having got beyond the control of the staff, and threatening to destroy the entire plant. Before the hose was got into play, the switchboard, running the whole length of the western wall, where, it is stated, the fire broke out, was completely destroyed. The cause of the fire is unknown, and the damage is estimated to exceed £10,000. Mr. J. R. Henry, the acting manager for Mr. Covernton, who was ill at the time, made arrangements to draw from the Robinson installation, and, to a certain extent, from the suburban station at Brakpan. These supplies, together with that from the three-phase plant, will form the total lighting supply, and, in consequence, the public have been warned to be as economical as possible.

Malton.—The Northern Counties Electricity Co. has secured premises on the banks of the River Derwent, as the site for its generating station.

Middlesbrough.—Sanction for the borrowing of a sum of £15,000 for extensions, has not yet been received by the T.C., but as no objection is anticipated from the L.G.B., the Council has decided to proceed with the work immediately.

Morriston.—The Swansea Corporation has resolved to adopt the scheme drawn up by Mr. Prusmann, the borough electrical engineer, for the lighting of the town, which provides for a supply of energy on the two-phase system, and that it should be run in conjunction with that section of its tramway system.

Morley.—During the past year the output of energy sold to consumers shows an increase of over 40 per cent., and the cost of generating has been reduced to about one-half, as compared with the previous year, this, it is stated, being due to improvements carried out at the works.

Newburn.—The D.C. has decided to approach the Newcastle and District Electric Lighting Co. with a view to obtaining a supply of energy from it.

Newquay.—The U.D.C. has sealed an agreement with the Southern Counties Electricity Corporation for the provision of electricity works in the town on the following terms:—Charges to the Council, 4d. per unit for public lighting, and 2½d. for power; private consumers, lighting 6d., power 3d. A year's notice of the Council's intention to purchase the undertaking is to be given, the terms to be on a sliding scale—viz., if within seven years, the price to be the amount of capital expended, plus 15 per cent.; if under 10 years, plus 10 per cent; after 14 years, plus 5 per cent., the works to be in proper working order.

Northfleet.—The U.D.C. has accepted the terms offered by the Kent Electric Power Co. for the taking over of its prov. order for the electric lighting of the district. The company agrees to pay the Council £250 towards the cost of the order, and the Council agrees to take a supply of energy for lighting the main streets.

Omagh.—The Board of Guardians has approved of the scheme proposed by a London syndicate for supplying energy for lighting and power in its district.

Portsmouth.—A L.G.B. inquiry was held last week in reference to an application by the T.C. for sanction to borrow £24,000 for electric lighting extensions. The town clerk stated that the last loan was £23,000. That was the estimated expenditure for the years 1901-2-3, but the amount actually spent was £25,253, an excess of £2,353. It was explained that the last estimate would have been quite sufficient had not the Admiralty unexpectedly required them to supply the naval barracks, the gunwharf, and part of the dockyard, which entailed a large expenditure, and a very profitable one. The application was unopposed.

St. Asaph.—The L.G.B. has assented to the Guardians entering into a contract with Messrs. D. T. Jones & Co., Rhyl, for the lighting of the new infirmary by electricity at a cost of £763.

Salford.—At the meeting of the B.C. last week a question was raised as to the charge for energy to shopkeepers and private consumers. It was stated to be four times as much as was charged to users for power, and twice as much as was paid by the Tramways Committee for traction purposes. Alderman Shaw explained that the plant at the Frederick Street station could generate 30,000,000 units per annum, whereas the estimated consumption up to the end of March last did not exceed 8,000,000 units. The Tramways Committee had taken over 5,000,000, and the Electricity Committee had therefore 22,000,000 to dispose of. The arrangement with large consumers was that they should have energy at a reduced rate of 2d. for the first 1,000 units, 1½d. for the next 10,000, and 1d. per 1,000 for anything over that quantity. If a manufacturer takes 325,000 units per quarter, the charge to him will be 1·006d. per unit.

Spain.—Application has been made for a concession to put down a plant to utilise the water-power of the River Lozoya in the generation of electrical energy at Buitrago (Madrid).

(*Continued on page* 103.)

SWINDON CORPORATION ELECTRICITY SUPPLY WORKS.

Swindon, with the remarkable development which it has undergone during comparatively recent years, may justly be regarded as one of the most progressive towns of the West of England. In 1891 the population was 33,001, and at the present time it reaches about 48,000. This great development is of course due to the laying down in Swindon by the Great Western Railway Co. of their principal locomotive and carriage works, the employés in which number over 13,000.

The Borough Council having been approached by one or two companies who wished to install plant for the supply of electricity to the town, decided to install a Corporation supply under its own provisional order granted in 1895, and also to lay down electric tramways. Messrs. Lacey & Sillar, consulting engineers, Westminster, were called in to report on the best system of supply for the town; the three-wire continuous current system was adopted, and plans and specifications were at once got out.

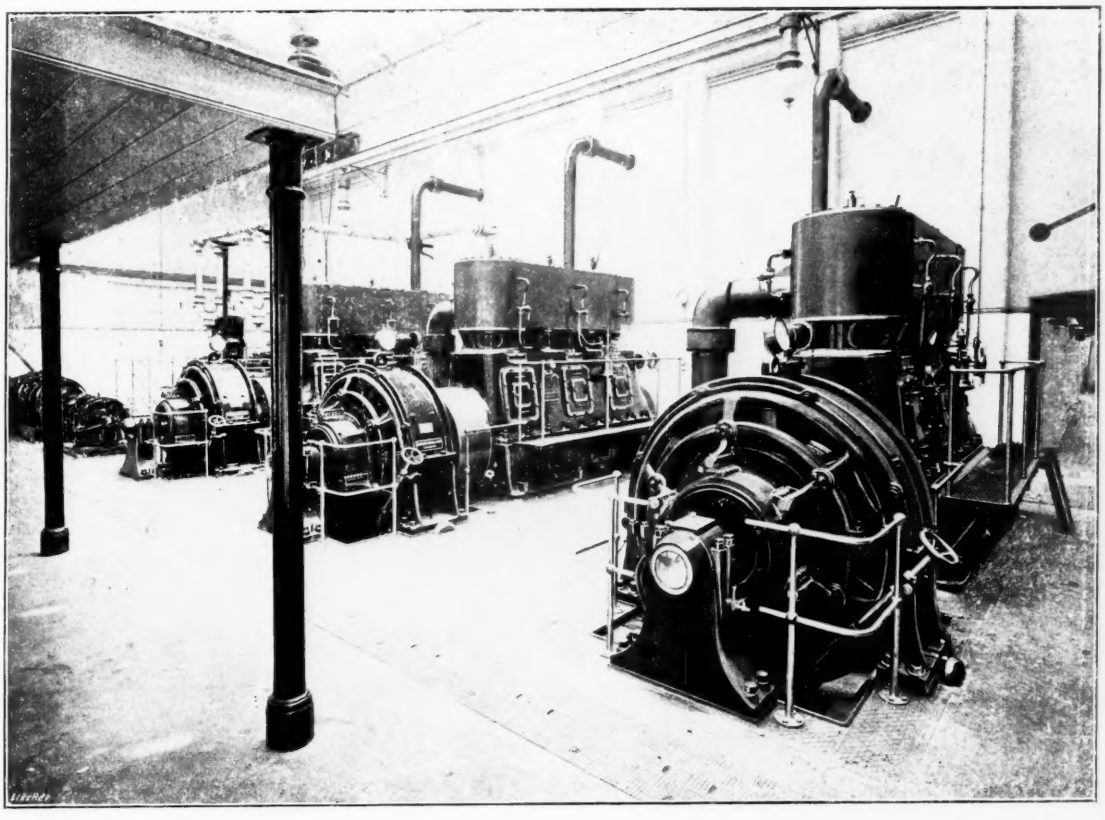
The contracts were let to the following firms, and the works were commenced in 1902 :—

Mr. A. J. Colborne, Swindon ...	Buildings.
Siemens Bros. & Co., Woolwich ...	Steam dynamos, motor-generators, balancers, &c.
James Carter & Sons, Stalybridge.	Boilers, condensing plant, and all the piping.
W. T. Glover & Co., Ltd, Manchester	Cables.
Tudor Accumulator Co., London	Batteries.
Bertram Thomas, Manchester ...	Lighting switchboard.
Venner & Co., London	Meters.
British Thomson-Houston Co. ...	Testing instruments.
R. J. Nicholson & Co, Manchester	Station lighting.
Carrick & Ritchie, Edinburgh ...	Travelling crane.
Keighley Elecl. Engineering Co.	Service and fuse boxes.

The site selected for the generating station was a large piece of land situated in Corporation Street, in what is known as New Swindon. Sufficient land was acquired to admit of extensions to the station and the erection of the car-sheds for the tramway department.

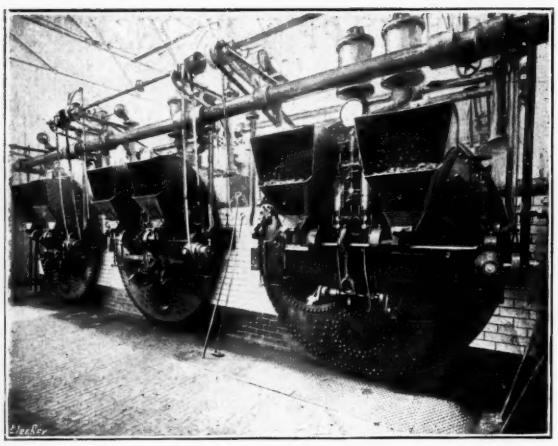
The buildings, which are entirely of brick, present a handsome appearance, and are certainly an acquisition to the town. They consist of the engine room, boiler room, pump room, battery room, test room, and large and roomy offices, all in the same block, with a fine chimney-stack in the centre.

The engine room, 63 ft. × 36 ft., is lofty, with glazed ventilating roof, and looks very neat with its dado of "Crystopal" tiles built round the walls, and its tiled floor. The engines are three Browett, Lindley & Co.'s three-crank enclosed vertical type, triple-expansion, capable of developing 350 B.H.P. when working condensing at 450 r.p.m., with piston type valves controlled by shaft governors. They are direct-coupled to three 200-KW. machines by Siemens Bros. & Co. These are six-pole type with carbon brushes, and with compound winding for the traction supply. The series winding is so arranged that the main current can be diverted as required through a shunt, and the compounding effect thus varied at will from nothing to "over-compounding."



General View of Generating Plant.

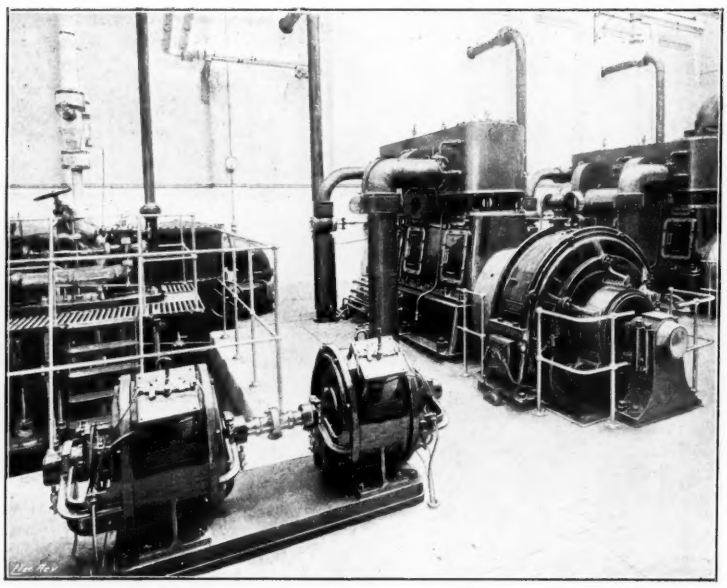
The balancer and motor-generator, supplied by Messrs. Siemens, are of the four-pole type. The balancer is capable of dealing with 100 amperes on the middle wire, and can automatically regulate with a load of 50 amperes



Lancashire Boilers, with Proctor Stokers.

thrown on either side without appreciably affecting the voltage.

The motor-generator comprises a motor in the centre, with a generator on each side; the motor is of 42 B.H.P., and the generators are wound for 220 to 310 volts. The general duty of this set is to charge the accumulators; but it may also be used to take current from the three-wire switchboard and supply it to the tramway board, or *vice versâ*. When working in this way, the two outer machines are connected across the three-wire system, and the centre one across the tramway bus-bars. It will be seen that, under this arrangement, one dynamo may be used to supply both lighting and traction, and, given good compounding on the dynamo and efficient governing on the engine, this system ought to be very useful to Swindon, as it is a town where very little day-load can be expected for some years. The alternative to this, of course, is to either run an engine all day on a light load, or spend another £1,000 or so on accumulators in providing a battery capable of dealing with the day-load.



Balancer, Condensing Plant, &c.

The switchboard, fixed on a gallery overlooking the engine room, was supplied by Bertram Thomas, of Manchester, and is of a very compact type. There are three panels for the three generators, each panel containing a Blackwell I.T.E. circuit breaker, ammeter, Thomson integrating wattmeter and fuses. The other end of the board at present has three feeder panels. In the centre are the battery regulating switches and the balancer starting and regulating switches. There are four bus-bars fixed across the back of the board, connected to two-way switches or plugs, so that either feeder or machine can be run on either bus-bar. On a panel by itself the motor-generator starting switch and regulating shunt resistance are fixed. Along the top of the board are fixed meters of the Weston "station" type with large illuminated dials.

A 10-ton travelling crane runs the length of the engine room, supplied by Messrs. Carrick & Ritchie, of Edinburgh. This is worked by hand, and is fitted with an automatic brake.

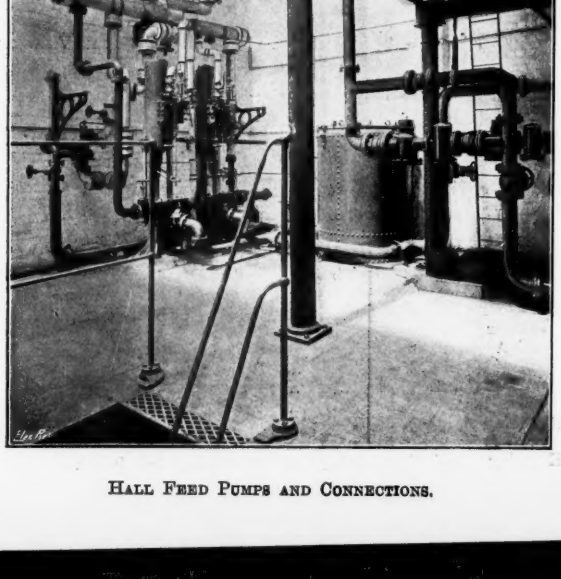
The condensing plant fixed at the entrance of the engine room is of the Carter jet type, consisting of two independent sets. Each set is capable, when dealing with 12,000 lbs. of steam per hour, of maintaining a vacuum of 26 in. This plant is also fitted with a Holden & Brooke grease extractor, capable of dealing with 25,000 lbs. of steam per hour.

The exhaust, condenser and circulating pipes, &c., are of cast-iron, amply provided with valves. The exhaust pipes are 18 in., 14 in. and 9 in. in diameter, the discharge pipes are 16 in., and the injection pipes 12 in. in diameter.

From the engine room we pass into the boiler room. There are at present three 30 ft. × 8 ft. Lancashire boilers by Tinker Shenton & Co., of Hyde. The working pressure is 180 lbs. These are fitted with Proctor's latest type of mechanical stokers with movable bars. There are two Westinghouse motors for driving the stokers, each motor being capable of driving the stokers for the three boilers.

The economisers are of the Pimbley type, divided into four sections in rows six tubes wide. The scraper gear is driven by a motor. The parts of the motors for driving the stokers and economisers are interchangeable in case of need. The tubes of these economisers are of an unusual type. Instead of the ordinary tube between the top and bottom circulating boxes, the connection is made with two tubes of helical shape, allowing the hot gases to pass between, and by this means getting a larger heating surface.

The steam range consists of lap-welded mild steel pipes with steel flanges. In this case the usual ring main is not provided. From each boiler stop valve a 6-in. pipe fitted with bend and tee piece is connected through a 6-in. valve to the main range, which runs the length of the boilers, and also through a valve to the 5-in. pipe to the engine. By this arrangement of the piping and valves



Hall Feed Pumps and Connections.

any of the boilers can supply any of the engines. We next come to the pump room. There are two feed pumps of the well-known Hall type, each capable of delivering 2,500 gallons per hour. The maker's guarantee with these pumps is 1 lb. of steam for 95 lbs. of water put into the boilers. As auxiliary there are two Holden & Brooke injectors of the same capacity as the pumps. The feed range is of ring form, with the economisers in the centre.

Motor in Recess. Main Switchboard.

Electricity in a French Cotton Mill.

Town's water is used, and the feed is so arranged that the suction can be taken from an overhead tank, the hotwell, or the cooler tank. The valves of the range, although numerous, are all above ground and easily distinguishable.

Siemens water meters are fixed in the town mains supply, and the boiler feed supply. A MacDougal coke filter is fixed in the boiler feed circuit, capable of thoroughly filtering 4,000 gallons per hour. The water from the condensers is pumped into the hotwell, and from there is raised to the top of the cooling tower by a rotary pump driven by a motor.

The cooling tower is arranged for natural draught, and has a cooling area of 33,400 sq. ft.; the height is 60 ft. and ground area 1,080 sq. ft. The tank below the tower has a capacity of about 35,000 gallons.

The battery room is situated next to the engine room. The accumulators are of the Tudor Co.'s L.E. 13 type, of 252 cells (two sets of 120 cells and six spares) with a capacity of 350 ampere-hours.

The works are well provided with light, having in addition to the ordinary glow lamps, four arc lamps in the engine room, two in the boiler house, one twin carbon in the pump room, and one outside overlooking the coal bunkers.

The mains were laid by Messrs. W. T. Glover and Co., of Trafford Park, Manchester, and are Diatrine-paper insulated lead-covered 3-core cables. The feeders are drawn into conduits, and the distributors are laid solid in wood troughing. The length of the feeders is 2·14 miles, and distributors 7·44 miles. The feeders are connected to the separate distributors through pillar boxes by switch fuses, and there are several disconnecting boxes in various parts of the town.

Considerable extensions to the mains have been carried out since the commencement of supply.

Mr. J. G. Griffin was appointed borough electrical engineer in September, 1902, and has supervised the laying down of the whole of the plant.

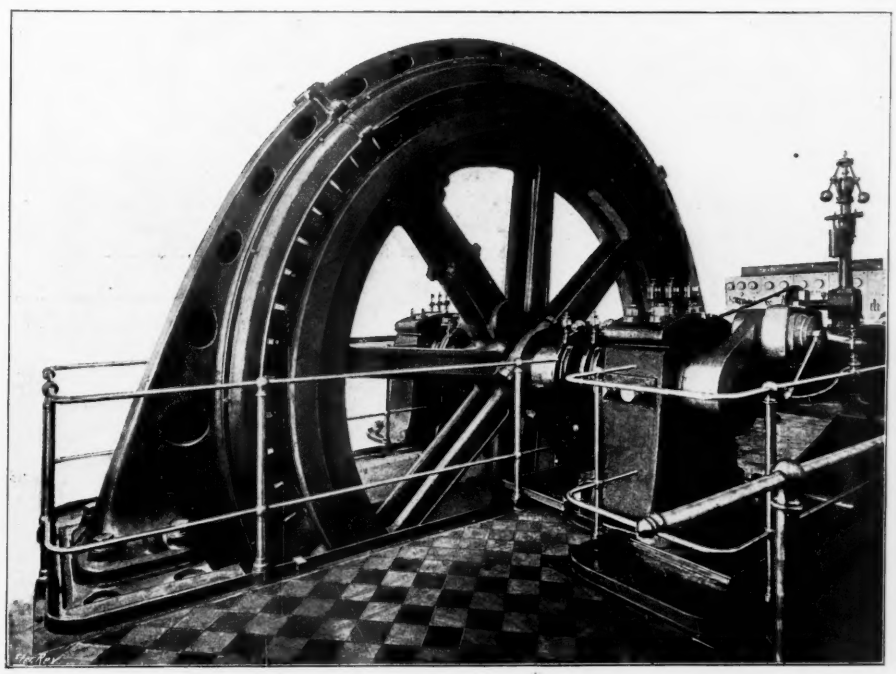
The supply was commenced on May 30th of last year. The number of lamps connected on that date was 2,727, and has since been increased to 7,550. The electrical engineer has instructions to convert all the gas lamps along the route of the distributors to electric. This is, of course, being done as quickly as possible, the number of lamps converted at the present time being 93; the Improved Electric Glow Lamp Co.'s glow lamps are used.

A large clothing factory in the town has already installed motor driving, and a steam laundry and several printers are about to do so. There are already over 7,000 lamps connected, and the undertaking appears to have a prosperous and satisfactory future before it.

The contracts are nearly all let for the construction of four miles of tramways, and the work is now proceeding.

ELECTRICITY IN A COTTON MILL.

An installation of electric lighting and power has been fitted by the General Electric Co., of Nancy, in the cotton mill at Mirecourt, one of the most important mills in France. This installation is worthy of the attention of technical men; in the first place, because it affords a simple and adequate solution of the problem of electric driving:

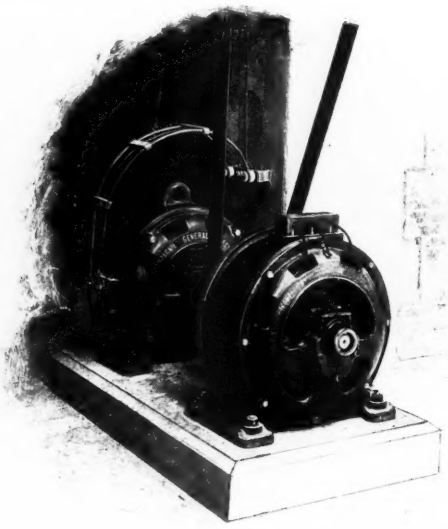


Main Three-phase Generator, Mirecourt.

secondly, because it is very unusual for spinning mills to be worked entirely by electricity.

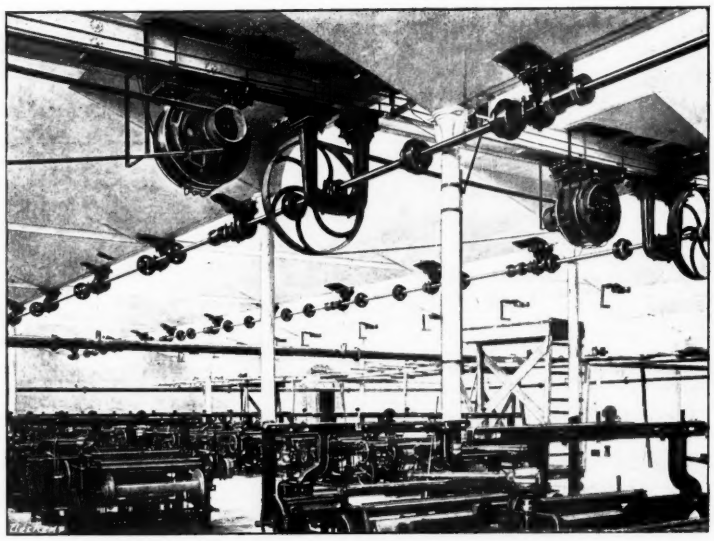
Experience has shown perfectly clearly that for all new work electric driving is much the simplest, leads to a great economy in first cost, gives a higher output, and with regard to the general disposition and planning of the buildings,

permits of the establishment of installations which would be absolutely impossible if ordinary mechanical transmission were adopted.



Motor-Generator.

However, up to the present, when there has been a question of applying electrical control to the whole of a new cotton mill, in arranging the buildings, workshops and motive power so as to derive the greatest advantages from electrical control, people have been deterred either by excessive caution, by the absence of precedents of this kind, or by difficulties more apparent than real, which have caused those manufacturers who have considered this question, to renounce electricity and adhere to the old methods of driving, with all the disadvantages which follow the establishment of a complicated mechanical transmission.



Motors Attached to Ceiling of Weaving Shed.

It must be admitted that among the principal objections to the general application of electric working have been in the past the comparatively high cost of the dynamos and motors, and their delicate construction and working, inducing fear of stoppages, and of high cost of maintenance.

These objections have been considerably modified by the numerous improvements which have been made in the construction of electrical machinery.

This plant possesses what renders it peculiarly well adapted to the very special conditions obtaining in the textile industries: the quality of running at speeds as constant and uniform as possible under variable loads, with continuous working and facility of control.

The management of the Mirecourt spinning mills had to choose for the driving of the factory between two projects, that of electrical driving, by the General Electric Co., of Nancy, and another based on the ordinary system of mechanical transmission.

In the latter project, the engine was to have been a tandem compound Corliss, of 600 I.H.P., intended to be coupled up, if necessary, in view of future enlargements, to transmit a total of 1,200 H.P. by means of ropes placed in the weaving room. This transmission would drive, by bevel gearing, the transverse shafts of the weaving machines, working each two lines of frames; on the other hand, the main shaft crossed a yard and worked the spinning machines by means of a system of ropes driving the cotton jigs, carding machines, bobbin frames, &c., representing about two-thirds of the power transmitted in the first instance.

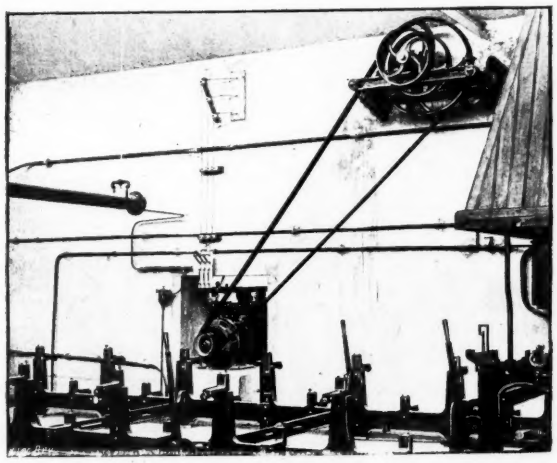
The choice fell on electrical working, because the Nancy Co. guaranteed (1) That the first cost of the installation would be 152,440 fr., as against 155,450 fr. for the mechanical transmission; (2) that the efficiency would be greater, 71·7 per cent., against 66·8 per cent.; (3) that the cost of upkeep would be reduced. The installation was carried out as follows:—

The engine is a Corliss tandem compound (constructed in Alsace by Bitschwiller-Thann), running at 100 r.p.m, and direct-coupled to an alternator of 600 H.P., of which the rotating part is made sufficiently heavy to act as a fly-wheel.

The alternator gives a three-phase alternating current with a frequency of 50 cycles per second at 400 volts. It can be excited either by a battery of accumulators, or by a motor-generator composed of an induction motor coupled to a dynamo. This transformer at the same time supplies power to the repairing shop. The alternator is of the type with fixed armature and revolving field magnet, with 60 poles. The armature is composed of thin sheet-iron laminations pierced with round holes near the inner edge, and is kept firmly in place by a cast-iron frame.

For ease in transport and handling, the armature is made in four pieces, ultimately bolted together, and each weighing about $3\frac{1}{2}$ tons.

The armature winding is composed of copper bars, 16 mm. in diameter, joined at the ends by copper connections 200 mm^2 in cross-section. This winding is carefully insulated from the core by means of insulating tubes. The fly-wheel magnet is made in two parts, each weighing about 12 tons, and joined together by bolts and by eight rings shrunk on. The switchboard is divided into panels, on which the



Motor in Wall, Driving Counter-shaft.

switches are so arranged that it is impossible to make a mistake.

The motor and lamp circuits are controlled from the switchboard; the motors receive directly the alternating current at 400 volts, but the lamps are arranged so that each receives 230 volts. The motors are of the induction type, with the rotor short-circuited. They are arranged in the following manner for spinning and weaving:—

Spinning.

Scutching and willowing machines...	One 20-H.P. motor.
Carding machines	One 30-H.P. motor.
Carding benches	One 15-H.P. motor.
Bobbin frames	One 45-H.P. motor.
Two lines of 250 bobbin frames ...	Two 100-H.P. motors.

Weaving.

Warping and preparing machinery...	One 11-H.P. motor.
Looms in eight parallel lines, driven by separate shafts... ...	Four 30-H.P. motors.

All the motors used for spinning are placed in recesses in the walls to avoid blocking up the passages. One of our views shows a 100-H.P. motor for the spinning machines, and another a 30-H.P. motor for the carding machines.

The switches and circuit-breakers have been placed in iron boxes. In this way the apparatus is entirely protected from dust, and it is impossible for any of the employés to put their hands on a conductor or anything from which it is possible to obtain a shock. For the weaving shed, the motor used for the preparing machines has been placed in the wall, and the motors which work the looms are suspended from the ceiling; thus no space has been lost. The pulleys of the above-mentioned motors are divided into two parts by a projecting disc, and they drive by means of two belts, one on each side of the disc, the shafts for two lines of looms; this method annuls the sideway pull of the belt, and diminishes the friction on the bearings. A special arrangement has been adopted for the control of the switches, which are worked by means of levers from the floor level. In this way the bringing down of conductors and apparatus within reach of the hand is avoided. This method presents also the advantage of securing a pleasing appearance, as a most unsightly effect would be produced by bringing six cables 15 mm. in diameter down a column only 20 cm. in diameter, and terminating with a switch and circuit-breaker occupying 50 cm. The starting-up of the installation is managed very simply; the alternator is excited by a battery before starting the engine. All the switches are closed, and the alternator is slowly run up. All the motors start at once, and accelerate as the engine runs faster. When this is up to full speed, the whole factory is in normal working order. The excitation is regulated to give the desired voltage at the switchboard, and the battery is replaced by an exciter. The starting occupies the same time and fulfils the same conditions as if the factory were mechanically operated.

Electrical control is better than mechanical control in that, if an accident takes place at some point in a factory operated mechanically, the whole of the machinery must be stopped, and cannot be started again until the damage is repaired, causing a great loss of time. With electromotors it is sufficient to cut out the motor which supplies the power at the point where the accident occurs, and the rest of the factory can continue working as though nothing had happened. The switch being placed near the motor, the machinery can be stopped at once, far more quickly than if it were necessary to stop the main engines. Plenty of time can be taken for the repair, without stopping the rest of the factory. Only when restarting is the factory stopped, the switch of the motor is closed, and the whole restarted immediately. The company furnishing the motors did not wish to fit them with a winding which would enable them to be started independently. If this were done, it would not be necessary to stop the entire factory, except in the event of an accident in the generating station; on the other hand, however, there would be the increased cost, and the rings and brushes, starting switches and cables would have made a far less simple installation than that which has been put in. On the other hand, the advantage which would have been secured was not sufficient to justify its employment, for with a simple plant and with special care given to the electrical installation, there will be little chance of accidents. As to those which might be caused by the looms and spinning machines, it is certain that with the existing plant they are very rare. It is for this reason, to make an installation in which the maximum simplicity and economy are realised, excluding all possibility of heavy maintenance, repairs and hand-labour, that the system of simultaneous starting has been adopted.

This system of electrical control, as installed at Mirecourt, has been working for about a year, and is giving entire satisfaction.

With a working day of 10 hours and a consumption of ·8 kgm. of coal per indicated horse-power-hour, the electrical system has economised 380 kgm. of coal a day, so that for a year of 300 working days and an average price of 30 fr. a ton, a yearly saving of 3,400 fr. would be effected.

As to maintenance, it has been practically nothing, which is almost entirely due to the strength of the the three-phase motors with the rotors short-circuited, and also to the absence of ropes and heavy belts, and the abolition of long and heavy transmissions and bevel gears.

The use of electricity has effected a saving on the first cost, and has increased the efficiency by about 5 per cent.

Experience has also shown that, owing to the absence of ropes and belts, which are subject to slipping according to the load, degree of tension, temperature, and the state of the weather, a much greater regularity of driving has been obtained in the working of the looms. This regularity is independent of the load, and depends entirely on the steady running of the engine, which, provided with a heavy fly-wheel necessary to obtain a coefficient of irregularity sufficient to enable alternators to be run in parallel, makes possible the production of thread and cloth with perfect uniformity.

LIGHTING AND POWER NOTES.

(*Continued from page* 98.)

Hoyland.—The Yorkshire Electric Power Co. has notified the D.C. they would supply energy at 2d. per unit.

Southampton.—The new power station of the Corporation on the western shore is nearly completed as far as the structure is concerned. Part of the plant has already been installed, viz., two horizontal compound condensing engines of 1,000 H.P. each, made by Messrs. Pollit & Co., coupled to Dick, Kerr continuous-current generators, designed for a 500-volt supply for the tramways or a 400-volt supply for lighting. One set only is, at present, running. Two Lancashire boilers have been installed, working at a pressure of 180 lbs., and one of the larger boilers at the old station is shortly to be re-installed in the new works.

Southport.—A very considerable increase in the assessment of the electricity works has been made. The Assessment Committee informed the T.C. that the works were under-assessed, and engaged an expert, with the result that the assessment was raised 500 per cent.—to £5,528. The Electricity Committee is appealing.

Stalybridge.—The Stalybridge, Hyde, Mossley and Dukinfield Electricity Board has decided that, for installations of 50 16-C.P. lamps, or its equivalent, after a consumption of 2,000 units has been reached, the price of energy shall be reduced by ½d. per unit for every additional 125 units per quarter, to a minimum of 4d.

Stockton-on-Tees. — The Electricity Committee has recommended that consumers using £25 worth of energy for lighting per annum should be charged at the rate of 2½d. per unit.

Stoke-on-Trent.—The T.C. has received a communication from the L.G.B. with reference to its application for sanction to borrow £30,640 for lighting purposes and the provision of a refuse destructor in connection with the proposed E.L. works. The Board approved generally of the proposals, but observed that the scheme included the provision of mortar-making plant. The general question of municipal trading had recently been under the consideration of Parliament, and pending a decision on the question the Board were not prepared to sanction a loan in respect of the proposed mortar-mills unless the Council gave a formal undertaking by resolution not to manufacture mortar for sale, but only to sell such surplus products of the plant as were not required for its own use. The Council passed a resolution embodying the suggested undertaking.

Switzerland.—The municipal authorities of Zurich have under consideration a project for the construction of a hydro-electric power station on the Etzel, by the engineers of the Oerlikon Co., the total cost of the power station and plant, &c., for a total of 60,000 H.P., would run into a matter of 35,670,000 fr.

West Ham.—At the last meeting of the T.C. the electrical engineer recommended the adoption of the rectified system at present in use, on certain new routes and also on five

other roads for the sake of uniformity and economy. The estimated cost of cables was £435. In regard to further arc lighting on the direct current system, he proposed to lay independent feeders to supply the arc lamps (the rails being utilised to convey the return current), when, by the use of a differential booster in conjunction with the storage battery at the generating station, the variation in pressure will not affect the arc lighting. He suggested the installation of continuous current lamps on all the routes with the exception of those already mentioned, recommending the adoption of open type lamps throughout the borough. With regard to the charges—£16 12s. was the estimated net cost to the electricity department to supply (at 1d. per unit) and maintain each arc lamp, this cost including a proper proportion of the capital and management costs. The following are the prices charged in the more important Metropolitan districts:—Islington, 3½d. per unit, about £30 per lamp per annum; Hampstead, £28; Hammersmith, £22 10s.; Poplar, £29 3s. 8d.; St. James's and Pall Mall Co., £30; City of London Electric Co., £26; Metropolitan Electric Supply Co., £30; Westminster Electric Supply, £22; West Ham, £20. He recommended that the present charge, £20, be made for these lamps. The report was adopted.

Westhoughton.—The U.D.C. has asked the South Lancashire Tramways Co., the Lancashire Electric Power Co., and the Hulton Colliery Co., to quote terms for supplying the Council with energy in bulk.

Whitby.—The L.G.B. has sanctioned a further loan of £2,000 for extensions at the electric lighting works.

Willesden.—At the last meeting of the U.D.C. a letter was read from the Metropolitan Electric Supply Co., stating that it was not aware of anything in the Council's prov. order entitling it to demand an assurance that the company would not supply energy from the works in Acton Lane to anyone in Willesden. It was resolved that, in the event of the company supplying energy in Willesden outside the defined area, legal proceedings would be taken, and that the N.W.R. Co. and various authorities who may be affected be informed of this decision. A sub-committee was appointed to report as to the acquisition of a suitable site for a generating station in the event of its being deemed advisable at any time to terminate the agreement for bulk supply.

Wrotham.—The U.D.C. has received, from a syndicate, notice of its intention to apply for E.L. powers for the district.

TRAMWAY AND RAILWAY NOTES.

Bath.—The *Morning Post* says that on Saturday evening a car on the recently-opened electric tramways in Bath got out of hand when descending Wells Pond, a steep slope, through the trolley rod becoming detached. The car dashed down the hill and ran into two coal wagons, killing one horse and injuring two others. The car, being a single-decker, did not capsize.

Berlin Electric Railway.—The Berlin correspondent of the *Standard* gives some figures relating to the working of the new electric overhead and underground railway started working in February, 1902. "The line, as it now exists, was only completed by the end of that year. Up to that date, the firm of Siemens & Halske managed the railway, guaranteeing 4 per cent. interest on the shares. The year 1903, the results of which have just been published, was the first in which the line was managed independently. During the twelvemonth it carried nearly 29,500,000 passengers, the month of December showing the largest traffic, with 2,870,000 passengers; March coming next with 2,700,000 passengers; and July being the worst, with only 2,093,000 passengers. The difference in the receipts between December and July has been equally marked, 257,000 marks being earned in July, and 355,000 marks in December. The electric traffic would, no doubt, be larger still, were it not for the complaints against the management and its complicated and troublesome regulations."

Buenos Ayres.—It is reported that the German Transmaine Electricity Co., which recently absorbed the electrical department of the Primitiva Gas and Electric Lighting Co., after having previously purchased the works of the French electric lighting company in Buenos Ayres, has now concluded an agreement with the Anglo-Argentine Tramways Co. for the supply of electric power to the latter for the whole period of its concession. As soon as the City of Buenos Ayres Tramways Co. has obtained the necessary authority to convert its lines to electric traction and the work has been completed, the German company will also supply power for the working of these tramways. The two tramway companies are said to have established a working arrangement.

Chili.—A company has just been formed in Berlin with a capital of £250,000 to be known as the Valparaiso Electric Tramways Co. The Allgemeine, Union, Siemens & Halske, and a number of other electrical concerns are interested in the new undertaking.

Electric Railway Projects in Austria.—The operation of main line railways by electricity is a matter of special interest to the governments of such countries as Norway and Sweden, Switzerland, Italy and Austria, all of which are endowed by Nature with great water-powers. The first three countries named have for some time been conducting inquiries into the possibility of employing electricity for working the railways, and Austria also has now taken up the question, and obtained detailed schemes. For the Arlberg railway, power could be obtained from the waters of the Inn, at Landeck, where a power of 7,000 KW. is available; a second fall can be utilised in the valley of the Oetz. For the new Alpine railways a fall is very conveniently available on the River Isonzo, of 11,000 to 15,000 KW. The metropolitan railways of Vienna are also to be converted to electric traction, but in this case a steam-driven plant of 15,000 KW. will be required, as there is no available water power. Owing largely to the unfavourable routes followed by the last-named lines, which were constructed as much for military purposes as for the convenience of the inhabitants, and to the enormous capital outlay upon them, they have not proved profitable in the past, and even when they are electrically operated, there is not much prospect of material improvement in this regard. The case is different with the main lines above mentioned, and if the Austrian Parliament can be induced to give attention to the proposal and to authorise the conversion, it is believed that great benefits will be derived by the commercial and industrial interests from its accomplishment.

Folkestone.—After much debate the T.C. on January 6th negatived proposals that a line of tramways on the overhead or any other system should be constructed from the Central Station to the Town Hall, and that the existing prov. order should be altered so as to include powers to adopt the overhead system. Eventually it was decided to appoint an expert to advise them on the surface-contact system.

Glasgow.—The Tramways Committee of the T.C. has agreed to accept the offer by Messrs. Duncan Stewart & Co., Ltd., to supply and put up a low-pressure steam system of heating for the car works at Coplawhill.

The proposal to extend the car system to Newton Mearns and Kirkintilloch has been remitted to a sub-committee for consideration and report.

Another sub-committee has been appointed to get an additional 100 cars of the most modern type, and to advertise for the necessary motors and equipments.

Great Northern and City Railway.—On Wednesday last, on the invitation of the contractors, Messrs. S. Pearson & Son, Ltd., representatives of the Press travelled over the newest "Tube" from Moorgate Street to Finsbury Park, and were entertained to luncheon at Drayton Park Station. The line is 3¼ miles in length, and taps one of the most important traffic routes in North London, traversing a district which is at present practically without quick transit facilities. The cost of construction has amounted to nearly three millions sterling, and the work has been in progress since the beginning of 1899.

The railway at present terminates in the City at Moorgate Street, but an extension to the Bank, at Lothbury, is in course of construction; at Moorgate Street a subway provides ready access to the Moorgate Street Station of the City and South London Railway, thus affording facilities for travelling between the north and south of London.

The construction of the railway marks important advances compared with the previously existing "tubes," the tunnels being no less than 16 ft. in diameter, large enough to admit the standard rolling stock of the Great Northern Railway, even when the carriage doors are open. It is interesting to note that the cost per mile was nevertheless no greater than on the Central London Railway. The carriages which have been built for the new line are remarkably large and roomy, and are provided with entrances at the middle as well as at both ends: the trains are, of course, operated on the multiple unit system, there being three motor-cars to a seven-coach train, and two to a four-coach train. Current is conveyed to the trains by a third rail at a pressure of 575 volts, and returned by a fourth, both being situated outside the running rails. Power is supplied direct from the generating station in Poole Street, on the Regent's Canal.

The approaches to the station platforms are exceptionally liberal in proportions; at Finsbury Park the booking hall is immediately under the main line platforms of the Great Northern Railway, and the tube platforms can be reached from thence both by inclined ways of short length and by very large lifts. In view of the enormous traffic which is certain to be met with at this point, these conveniences are obviously very necessary.

The platforms, signal-boxes and other structures below ground are entirely fireproof, a consideration of the first importance.

The generating station contains four 1,250-I.H.P. Musgrave vertical compound engines coupled to British Thomson-Houston generators for operating the trains, and auxiliary plant for lighting the tunnel and stations.

The fares charged will be 2d. between termini, and 1d. between some of the intermediate stations and the termini; season tickets will cost only £4 per annum, a reduction of one-third as compared with existing rates. It is proposed to maintain a three-minute service throughout the day, the journey from end to end being accomplished in 13½ minutes, including four 20-second stops at intermediate stations.

The chairman of the Board of Directors is Sir Charles Scotter. The consulting engineers were Sir Douglas Fox & Partners, represented by Mr. D. L. Hutchinson. The part of the railway between Drayton Park and Finsbury Park has been carried out by the Great Northern Railway Co., under the chief engineer of the company, Mr. Alex. Ross.

The contractors for the construction were Messrs. S. Pearson and Son, Ltd., who constructed the Blackwall Tunnel, and are engaged on the National Harbour Works at Dover, and other important undertakings; one of their directors, Mr. E. W. Moir, has had charge of the work on their account. Messrs. Pearson will be

responsible for working the line for three years from the opening. The general control and engineering of the line will be in the hands of Mr. R. P. Brousson, who was engaged in the construction of both this railway and the Central London Railway.

The principal sub-contractors were the British Thomson-Houston Co., of Rugby, who were responsible for the whole of the generating plant, line equipment, and rolling stock. The B.T.H. Co.'s multiple-unit system is employed in working the trains, and they supplied the main and auxiliary generators, the switchboards, the motors and controlling gear on the motor-cars, and all other electrical apparatus.

The main engines were supplied by Messrs. J. Musgrave & Son, of Bolton, and the auxiliary engines by Messrs. Davey, Paxman & Co., Ltd., of Colchester; the latter firm also supplied the boilers, which are of their well-known "Economic" type. The electric lifts were supplied by Messrs. Easton & Co., of Erith, and the electric-hydraulic lifts at Finsbury Park by the Chester Engineering Hydraulic Co. The rolling-stock was supplied by the Electric Railway and Tramway Carriage Works, Ltd., of Preston, and the Brush Electrical Engineering Co., Ltd., of Loughborough.

As we propose to publish a detailed illustrated account of the undertaking at an early opportunity, we defer further particulars for the present. In conclusion, we may express our cordial appreciation of the admirable manner in which the work has been carried out. We have inspected many electric railways both at home and abroad, and we have no hesitation in classing the Great Northern and City in the foremost rank.

Huddersfield.—The borough treasurer has prepared a financial statement for the nine months ended December 31st, 1903. From this it appears that on the tramways 1,237,763 miles have been run, as against 970,211 last year. The receipts equal 9·83d. per car-mile, compared with 10·51d. for the same period of the previous year. The receipts amount to £50,676 17s. 8d., and the total working expenditure is £26,781 6s. 11d., giving a gross surplus of £23,895 10s. 9d. Of this £11,658 11s. 3d. is absorbed by payment of interest on the debt, and the redemption of debt is responsible for £8,341 10s., making a total of £20,000, and leaving a surplus of £3,895 9s. 6d. This statement does not include any provision for depreciation purposes.

The Tramways Committee has altered previous arrangements with regard to workmen's cars, and is now issuing return tickets, which are available on all cars arriving in Huddersfield at or before 8 a.m., the return journey to be completed on the upper saloon between 5.30 and 7.30 in the evening, and 12 and 1.30 on Saturdays. In addition, a statutory workmen's car is being run on each section where the fares demand such a concession.

At a cost of about £1,800, the Tramways Committee contemplates purchasing rolling stock and laying rails which will enable it to enter the railway companies' goods yard for the purpose of effecting the haulage of coal to one of the largest mills in the district. The town clerk is drafting an agreement, and as soon as it has been signed by the railway companies, the tenders for the necessary work will be let.

L. & Y. Electrification.—On Sunday further trial trips were run with the new electrical trains over parts of the electrified lines of the L. & Y. Railway Co. between Liverpool and Southport. It is now expected, according to a correspondent, that the opening of this electric railway will be not later than March 1st.

Leeds.—After a long debate, the City Council last week decided to adopt the "split turn" system for the tramway department employés, by way of a trial in the first instance.

L.C.C.—On Tuesday last, by the Council's invitation, a large number of municipal councillors and Press representatives went for a "special inspection" on the new conduit lines which are now ready to commence running for public service between Elephant and Castle, New Cross and Greenwich. The lines, which will be opened as soon as possible after the B. of T. certificate is received—probably by Sunday or Monday next—are fed from sub-stations which have been provided at New Cross, Camberwell, and the Elephant and Castle. These motor-generator sub-stations receive a 6,600-volt three-phase current from two sets of plant intended for the Greenwich power station when it is ready for them, but which have been temporarily installed at the London Electric Supply Corporation's station at Deptford. They feed the direct current to this 8 miles of double track at the customary pressure.

Manchester.—The citizens have endorsed the proposals of the Tramways Committee with regard to pending undertakings in the city and district. It is proposed to construct within the city four miles of new tramway (single track), at a cost of £33,000. There will be a double line round the infirmary building as soon as the necessary street widenings have been effected, and other lines will be formed in Mill Street, from its junction with Great Ancoats Street, to the corner of Beswick Street, Bradford Road. The Bill which is being promoted to obtain Parliamentary sanction for these extensions, also provides for extensions in other districts, outside the city, including short lengths of rails to form connecting links with tramways at Sale, Altrincham, and Dunham Massey; and it will legalise the agreements made during 1903, with Ashton-under-Lyne, Altrincham and Withington, in relation to tramway communication. Other powers sought by the Bill relate to the supply of electricity beyond the limits of the city, the laying of mains and the execution of works for that purpose. Lines outside the city, to be constructed under this Bill, measure rather over one mile, and are estimated to cost £8,500. Road widenings in Sale and Northenden are put down at £3,500, and at Withington, £85,000; making a total of £130,000.

Motherwell.—The Tramways Co.'s generating station being now completed, they have relinquished taking a supply of energy from the T.C.

N.E. Railway.—Within the course of the next fortnight the final draft for the service of electric trains will be settled. Though the entire installation is not yet completed, the board is considering the advisability of commencing a service of trains over the completed portions.

Paisley.—Mr. Murphy, who is constructing the Paisley and district electric tramways, has written to Johnstone T.C. to the effect that he intends to seek powers to connect Kilbardan with the Paisley and Johnstone system.

Rome—Naples Electric Railway.—The Commission appointed some time ago by the Italian Government to examine the project of the construction of a direct electric railway between Rome and Naples has concluded its report, in the course of which it states that, apart from the line of 249 kilometres already connecting the two cities, which distance it takes a fast train five hours to cover, it is desirable to construct a double line of electric railway about 7 kilometres from the coast. The maximum incline shall not surpass 15 per cent., and the curves shall not surpass 900 metres. The termini will in each case be placed in the centre of the town. There will be 15 intermediate stations. The line will be 203 kilometres long, and will cost about 93,380,000 fr. The Commission is of opinion that preference should be given to the system of traction employed on the Valtellina and Marienfeld—Zossen lines. It is of opinion that the trains should be formed of several motor-cars with multiple unit control (Thomson-Houston system), while the Thompson-Webb block system should also be adopted. It is calculated that a train composed of three motor-cars, each of 120 tons, and running at a speed of 100 kilometres per hour, would entail a consumption of energy of 1,500 H.P., or for six trains running simultaneously 9,000 H.P. The Commission suggests the construction of sub-stations at Cisternau and Sessa Aurunca, both situated at about 50 kilometres respectively from the terminals. The necessary plant would cost a matter of 16,000,000 or 17,000,000 fr., making the total expense a question of 110,000,000 fr.

Southport.—The T.C. has instructed the electrical engineer to submit an estimate of the cost of electrically equipping the tramway on the pier.

South Shields.—At a meeting of the T.C. on the 6th inst. Alderman Marshall moved, on the recommendation of the Tramways Committee, that the Council's resolution—"That the T.C., in any event, themselves construct the tramways and provide the electrical equipment," which was passed on October 28th last, be rescinded. He explained that they wanted a free hand in dealing with the matter, whereas if the resolution stood as it was it meant that even if they decided to lease the tramways they would still have to construct them and equip them. They would, of course, have to find the capital, and if they leased them it meant that those who took them would simply step in and take them over. Mr. Grant seconded. Mr. Batey, although favouring municipalisation, reminded the Council of what happened with the old company. The Corporation laid the lines themselves and leased them, and then after working them for some years the company left the Corporation with a debt of £8,000 to £10,000. If the Council had then done what it proposed to do now the town would not have been burdened with the debt. Other members spoke in favour of the proposal, most holding that the only businesslike position for them to take up was to be absolutely unfettered by conditions when considering whether or not the tramways should be leased. The motion was carried by a large majority.

Wakefield.—The Wakefield and District Light Railway Co., whose light railways are now being constructed, and will shortly be opened for public traffic, has deposited a Bill in Parliament for next session seeking power to construct electric trolley tramways in Wakefield, Pontefract, Normanton, Whitwood, Castleford, Featherstone and Knottingley, of a total length of over 25 miles, at an estimated cost of £183,918. The company seek powers to raise £165,000 additional capital, with the right to borrow a further sum of £55,000, but the Bill expressly provides that the company shall not create debenture stock.

Wallasey.—On Monday a meeting of ratepayers was held to consider the proposed tramway scheme and Bill. After a long discussion on the subject, a resolution proposed by the chairman of the D.C., that the Council proceed with the promotion of a Bill in the next session of Parliament, was defeated by a very large majority.

West Fife.—A large tramway scheme is at present under consideration for West of Fife by the Fife Electric Power Co. Surveys have been recently made.

Wolverhampton.—Application is to be made to the B. of T. for their sanction to a loan of £15,221 for the reconstruction of the Dudley Road tramway from the Fighting Cocks to Temple Street, as authorised by the Town Council last October. The Board is also to be asked to sanction a loan of £1,293 for the construction of the Snow Hill tramway, from the Villiers statue to the corner of Bilston Street. Subject to the Board's consent, a single line of track is to be constructed upon that portion of the Willenhall Road between Coventry Street and Stowheath Lane, which is situate within the Borough of Wolverhampton.

Wood Green—Enfield.—At the Southgate U.D.C. meeting the other day it was reported that the order authorising the construction of a light railway along Green Lanes from Wood Green to Enfield, a distance of about four miles, had just been confirmed by the Board of Trade. The scheme is being carried out by the Middlesex County Council, and the cost of road construction is estimated at £36,500. As far as possible, the road for the entire distance will be made a uniform width of 60 ft.

TELEGRAPH AND TELEPHONE NOTES.

Russian Telephones.—The Russian journal *Rouskïa Viedomosti* gives some particulars of the recently installed central telephone exchange at Moscow. The building is of six storeys, with basement. In the uppermost storey is installed the instrument room, which serves 22,500 subscribers. The fifth storey is occupied by the accumulators and machines; the fourth by the cloak rooms, &c., of the staff; the third by dining room, drawing room, game room, library, &c. The second and the first storeys contain the administrative offices. Finally, in the basement, are situated the store rooms, workshops and boiler house. The building is lighted by electricity and heated by steam. The installation has cost about 200,000 roubles. As soon as this exchange is opened, the telephone apparatus on subscribers' premises will have to be modified. A new apparatus will be supplied to each, the simple lifting of the receiver of which suffices to call the exchange by lighting a small red electric lamp. As soon as the conversation terminates, the subscriber replaces the receiver, and the red lamp is extinguished, a white one lighting in its place. The operator breaks the connection only when the number called by the first correspondent has also hung up his receiver, which fact she is also made aware of by the changing of the colour of the light.

Telegraphic Interruptions and Repairs:—

Cables.	Interrupted.	Repaired.
Dominica-Martinique	May 5, 1902	
St. Lucia-Martinique	May 7, 1902	
St. Lucia-St. Vincent	Sept. 19, 1902	
Trinidad-Demerara No. 1	Aug. 27, 1901	
St. Thomas-St. Kitts	Dec. 21, 1903	Jan. 6, 1904
St. Kitts-Antigua	Jan. 8, 1904	
St. Vincent-Grenada	Dec. 28, 1903	
Mole St. Nicolas-Port-au-Prince	Dec. 16, 1903	
Cayenne-Pinheiro	Aug. 18, 1902	
Paramaribo-Cayenne	Feb. 26, 1903	
New York-Hayti	April 18, 1903	
Anjer-Kalianda	Aug. 2, 1902	
Reissa-Issa (Yemen)-Camaran	Oct. 22, 1902	
Tourane-Amoy	Nov. 10, 1903	
St. Jacques-Haiphong	Dec. 15, 1903	Jan. 11, 1904

CONTRACTS OPEN AND CLOSED.

OPEN.

Belfast. — January 15th. Electricity meters. See "Official Notices" December 25th.

Belfast.—January 22nd. Motor-balancer and motor-boosters. See "Official Notices" January 8th.

Belgium.—January 16th. Tenders are being invited until the 16th inst. by the municipal authorities of Liège for the supply of the track material and apparatus required for the Maghin-Fetinne-Guillemins electric tramway. Particulars may be obtained for 12 fr. from the Bureau Administratif, and tenders are to be sent to L'Annexe de l'Hotel de Ville, Liège.

Brighton.—January 18th. Tramway poles, wire, section pillars, overhead construction, cables, bonds, &c., for the Corporation. See "Official Notices" January 8th.

Chili.—June 28th. Tenders are being invited for the public electric lighting of the city of Punta Arenas (Straits of Magellan), which will be opened on June 28th next, at 2 p.m., in the offices of the Municipality Commissioners of that city. Full particulars can be obtained on application to the Chilian Legation, 29, Queen's Gate Terrace, S.W.

Cleckheaton.—January 18th. Distributing cables, for the U.D.C. See "Official Notices" to-day.

Enniscorthy.—January 20th. Electric lighting and pumping plant (seven sections), for the Lunatic Asylum. See "Official Notices" December 4th.

Erith.—January 18th. Lancashire boilers, piping, condensing plant, three-phase steam alternator of 500 KW., switchboard and cable extensions. See "Official Notices" December 18th.

Germany.—January 23rd. The Prussian State Railway Authorities at Altona are inviting tenders until the 23rd inst. for the supply of 300,000 arc lamp carbons, and 4,800 incandescent lamps. Particulars may be obtained from, and tenders are to be sent to, Die Königliche Eisenbahn Direktion, Altona.

Harrismith (Orange River).—January 18th. Cables, transformers, switchgear, &c. See "Official Notices" December 11th.

Hornsey.—February 8th. Two dryback boilers, smoke consuming apparatus, 100 and 300-KW. steam dynamos, motor-generators. See "Official Notices" January 8th.

Ilkeston.—January 21st. Stores for the tramway and electricity department. See "Official Notices" January 8th.

L.C.C.—January 19th. Six electrically-driven three-throw boiler feed pumps for Greenwich power station. See "Official Notices" November 20th.

L.C.C.—February 2nd. Tenders are being invited for roadwork and platelaying for the electrifying of certain tramways in South London. Particulars, &c., at the Engineer's Department, L.C.C.

Manchester.—January 18th. Car bodies, equipments and trucks. See "Official Notices" to-day.

May-Oatway Installations.—January 20th. Tenders for wiring premises at Paisley and Dundee on this system are invited. See "Official Notices" to-day.

Pontypridd.—January 15th. Pipe work and electricity meters for the Council. See "Official Notices" January 1st.

Rochdale.—January 30th. Electric lighting alterations at the Workhouse. See "Official Notices" to-day.

South Shields.—March 12th. The Corporation invites offers for the lease of certain tramways. See "Official Notices" to-day.

Spain.—February 12th. Concession for an electric tramway between Porrino and Mondariz (Pontevedra province). See "Contracts Open" December 18th.

Spain.—February 15th. The Public Harbour authorities at Barcelona are inviting tenders until February 15th for the contract for the establishment of the plant and equipment for the electric lighting of the sheds at the Port of Barcelonnette, and for the operation of the cranes, travellers, &c.

Wallasey.—January 16th. Cables, joint and section boxes. See "Official Notices" December 18th.

Whitby.—January 25th. Cables for the electricity department. See "Official Notices" January 8th.

CLOSED.

Battersea.—The B.C. has accepted the tender of Callender's Cable and Construction Co. to supply and fix a feeder in St. John's Hill, for £762.

Brighton.—In reply to the Tramway Department's advertisement for steam generating plant, the following tenders have been received:—

Messrs. Heenan & Froude	£20,901
Sir Hiram Maxim & Co., Ltd.	25,941
E. Danks & Co.	26,957
Messrs. Babcock & Wilcox	28,140
The Stirling Boiler Co.	29,594
" " " " (alternative)	30,741
C. G. Reed & Sons, Brighton	33,864
J. Fraser & Sons	38,578

The consulting engineer, Mr. Arthur Wright, in making his report to the Committee, recommended the acceptance of the offer of Messrs. Babcock & Wilcox, which, although not the lowest in first cost, he was satisfied would be the best in the end. After a considerable amount of discussion, the Council decided to accept the offer of Messrs. Babcock & Wilcox, the existing boilers of the same make having proved quite satisfactory.

France.—The French Post and Telegraph Authorities in Paris have just given out the following contracts:—La Société Metallurgie de Gorcy (Meurthe et Moselle) 70 tons of galvanised iron wire (4 mm. diameter) at 247 fr. per ton and 70 tons ditto at 240 fr.; La Société Alsacienne de Constructions Mecaniques, Belfort, 125 kilometres of lead-cased, rubber-insulated, single-conductor telephone cable at 335 fr. per kilometre; and La Société Industrielles des Telephones, 125 kilometres ditto at 335 fr.

Halifax.—The Corporation has accepted the tender of the Chloride Electrical Storage Syndicate for overhauling the exciter battery for £126. An order has been placed with the British Thomson-Houston Co. for two switchboard panels (£212); two Bennis stokers for boilers at the electricity works have been ordered from E. Bennis & Co., Ltd.

Hammersmith.—The B.C. has accepted the tender of Messrs. Fuller, Wenstrom & Co. to supply a 30-H.P. electric motor, for £130. An order for switchboards, to cost £242 10s., has been placed with Messrs. Ferranti, Ltd.

Metropolitan Asylums Board.—At last Saturday's meeting of the Board a letter was read from the L.G.B. sanctioning a proposal to enter into contracts without first advertising for tenders, with Messrs. Belliss & Morcom, Ltd., to supply additional generating plant at the Grove Hospital for £1,136, and with Messrs. Drake & Gorham, Ltd., to wire the Fountain Hospital for £2,792.

Portsmouth.—The following tenders for an extension of the switchboard were received by the Telephone Committee:—The International Electric Co., £645; British Insulated & Helsby Cables, Ltd., £800; Ericsson Telephone Bell Co., £917. The Committee's recommendation that the first tender be accepted has been adopted by the T.C. The Committee received the following tenders for wall and table instruments, and on their recommendation the tender of the International Electric Co. for 50 wall instruments at 45s. 9d., and 20 table instruments at 48s. 9d. each was accepted by the T.C. The other tenders were:—Ericsson Bell Co. 47s. 4d. and 49s. 8d.; L. M. Ericsson & Co., Ltd., 46s. 8d. and 49s. 6d. The Committee are authorised to purchase at the prices of the successful tender 150 more wall instruments and 30 table instruments if the first delivery is satisfactory to Mr. Bennett and in accordance with his specification.

Wolverhampton.—The Corporation has accepted the tender of Messrs. Milnes & Co., Ltd., of Hadley, for a salt feeder car for the tram rails, at £160.

Worthing.—The Hart Accumulator Co. has received the contract for replacing the existing battery in use at the electricity works here, with 264 of their standard lighting type cells.

FORTHCOMING EVENTS.

Saturday, January 16th.—Association of Engineers-in-Charge. Dance.

Tuesday, January 19th.—At 7.30 p.m. Institution of Electrical Engineers (Manchester). "Coal Consumption in Central Stations," by Mr. A. S. Giles.

At 8 p.m. Institution of Civil Engineers. "The Electrical Reconstruction of the South London Tramways on the Conduit System," by Mr. A. Millar. (Adjourned discussion.)

Wednesday, January 20th.—At 8 p.m. Liverpool Engineering Society. Mr. H. S. Meyer on "Voltage Regulation in Alternating Current Plants."

At 7.30 p.m. Institution of Electrical Engineers (Students). "The Equipment of a Sub-station with Rotary Converters," by O. J. Davis.

At 2.30 p.m. Institution of Civil Engineers. Students' visit to Messrs. Elliott Bros.' works at Lewisham.

Thursday, January 21st.—Institution of Electrical Engineers (Leeds). Mr. H. Bohle on "Alternators in Parallel."

Friday, January 22nd.—At 8 p.m. Physical Society. Meeting at the Royal College of Science. "The Photographic Action of Radium Rays," by Mr. S. Skinner. Exhibition of Instruments, by Messrs. Crompton & Co.

At 8 p.m. Junior Institution of Engineers. Presidential address by Mr. J. Fletcher Moulton, K.C., F.R.S.

Saturday, January 23rd.—At 7.30 p.m. Glasgow Technical College Scientific Society. "Some Observations on Mechanical Training, by Mr. W. D. Hamilton.

Wednesday, January 27th.—At 8.30 p.m. Unveiling of the tablet erected to the memory of the Electrical Volunteers who died in South Africa during the war.

At 7.30 p.m. Institution of Electrical Engineers (Birmingham). Mr. C. A. Smith on "Energy Distribution to Sub-stations," and short demonstration on "Some Uses of the Oscillograph," by Dr. D. K. Morris and Mr. J. K. Catterson-Smith.

NOTES.

The Cord Galvanometer and Electrocardiograms.—The cord galvanometer of M. Einthover (*Archives Neerlandaises*, Vol. VI., p. 625, 1901) consists essentially of a quartz fibre, silvered, and hung in a strong magnetic field. When a current is sent through it the fibre deflects perpendicularly to the lines of magnetic flux, and the deflection is read by means of a microscope and micrometer. The instrument is now very perfect for currents below 10 or 12 milliamperes, and has been adapted to record the deflections on sensitised paper. It has been applied to draw the electrocardiograms of Mr. D. Waller, that is to say, curves of the action of the heart. These curves show that the action of the heart is so characteristic, as a rule, that persons might be recognised by their cardiogram as by their finger prints.

Heavy Rails.—The rails for electric tramways have long surpassed those of the steam railroad in weight, but it is reported that the Pennsylvania railroad has placed an order for 3,400 tons of rails, which will weigh 140 lbs. per yard. If these rails could only be continuous, they would, indeed, form a very perfect track, but, as with all rails, there will be more or less trouble at the joints. The Zossen experiments on high speed electrical running demonstrated sufficiently the importance of a heavy rail for high speeds. The locomotives of to-day are fully as heavy in relation to the rails of to-day as were those of thirty or forty years ago to the 60-lb. rails of the time.

Contact Electricity of Liquids.—M. Berthelot, the famous chemist, has made over 2,000 determinations of the electromotive force developed by contact of liquids, such as dilute acids opposed to dilute bases, dissolved oxidants opposed to dissolved oxidisable substances, &c. The results are given in the *Annales de Physique et de Chemie*, and in ten memoirs to the Academy of Sciences, Paris. In the *Comptes Rendus*, December 7th, he claims to have demonstrated by these observations that the electromotive forces thus got from the reciprocal action of liquids are capable of developing continuous currents strong enough to perform work in the shape of continuous electrolysis. This work is maintained by the energy of chemical reaction, arising from direct contact of the liquids without the agency of metallic electrodes, as in ordinary batteries. Between the values of the forces thus developed there is a series of general relations which had not been enunciated hitherto. This order of phenomena merits particular attention from the double point of view of electrochemical theory and scientific or industrial applications. Theory and applications have only taken into account the electric forces and effects developed at the contact of liquids with electrodes, especially metallic electrodes, but it will be well, he thinks, to look more closely into those developed by contact of liquids with liquids. It may be worth trying to utilise electrically the chemical energies engendered by the reactions of neutralisation and oxidation between liquids alone, such as occur daily in the laboratory or in industrial operations.

The Explosion on the "Wallaroo."—The explosion on the *Wallaroo* cruiser, which was erroneously reported to have caused the death of 43 men, was quickly seized upon as a text on which to preach the virtues of water-tube boilers. Fortunately for human suffering the report was wrong, four men being killed and three being hurt. This is bad enough, but it is small in comparison with the water-tube disasters that have occurred. Any one of the boiler insurances will furnish figures of boiler explosions, which show that shell boilers, however faulty in idea, are far safer than water-tube boilers. Shell boilers do not explode as regards the shell. They fail in the flat stayed surfaces of the combustion chamber. The *Wallaroo* failure appears to be a combustion chamber failure, owing to giving way of the crown stays, which let the crown down, rupturing as it collapsed and letting out the contents of the boiler into the stokehold with the fatal results known. Shell boilers have, we believe, not been known to explode from failure of the shell in any vessel. Stayed combustion chambers are the weak spots, but circular furnaces of modern types will collapse from overheating, and will not often tear in doing so. The shell boiler with circular flues is certainly a safer boiler than any water-tube boiler that has yet been tried in the Navy. The many Belleville failures, the failure on the French vessel *Friant* and others all point to the danger of the flatly inclined tube full, or rather not full, of water. The *Wallaroo* has been moderate in her life destruction compared with water-tube failures.

High-Pressure Transmission in America.—One of the longest power transmission lines in the U.S.A. was to be put in operation at the end of last month; this is the Washington Water-Power Co.'s system, near Spokane, and comprises two three-phase alternators of 2,250 KW. each, driven by Victor turbines with a head of 70 ft. The generators work at 4,000 volts, and are controlled by motor-driven switch-gear operated by means of relays on the switchboard. Supply to the town is carried out at the above pressure, and arrangements are made for separating the local service from the transmission system. For the latter the pressure is stepped up, by means of water-cooled transformers, to 60,000 volts, at which pressure it is conveyed by three No. 2 copper wires on Locke porcelain insulators, to six sub-stations. The distance to the farthest consumer is no less than 110 miles. The line has been tested for some time at the full pressure, without mishap, but, if necessary, the pressure can be reduced to 45,000 volts by altering the connections of the transformers. Almost the whole of the power thus transmitted will be used for mining purposes. The electrical plant was built by the General Electric Co., U.S.A.—*Western Electrician.*

The Chicago Theatre Fire.—A New York correspondent, writing on January 2nd, says:—"The preliminary inquiries into the cause of the disastrous fire at the Iroquois Theatre, Chicago, on December 30th, show that the scenery was ignited by means of a falling spark from a 'spot light.' A 'spot light' is a movable electrical arc lamp, which throws a concentrated beam upon a performer, and to facilitate its use there is generally a lot of loose cable attached to it. No gas was used in the theatre, the building being lit by 2,000 electric lamps. The municipal electrician declares that to his personal knowledge all the electrical equipment was in perfect working order, everything being new at the opening of the theatre on November 30th. It is admitted, however, that there was no fire alarm attached to the building, the brigade having to be summoned by an antiquated method. Pending the Coroner's inquiry, the chief electrician of the theatre, Mr. Archibald Barnard, has been placed under arrest, charged with manslaughter. The jury visited the theatre soon after the fire, and they have formulated the following, among other questions:—'Did the management permit the use of arc lights in the flies with no device to prevent sparks from the carbons igniting the borders of the scenery and curtains?'"

Technical Education.—At the Technical Education Conference, which was held at Chelsea last week, Mr. W. Hibbert, of the Regent Street Polytechnic, exhibited and explained some new instruments and apparatus for the teaching of electricity and magnetism.

Obituary. — DR. VON HEFNER-ALTENECK. — It is announced from Berlin that Dr. Friedrich von Hefner-Alteneck, a member of the German Academy of Sciences, and a well-known engineer, died on 7th inst., from the effects of an apoplectic stroke. He was born at Aschaffenburg in 1845, and after studying at Munich and Zurich he entered the firm of Siemens & Halske, with which he remained until 1890. He became chief engineer of the firm, and was the inventor of many of the electric appliances produced by it.

MR. R. C. QUIN.—It also falls to our lot this week to lament the death of Mr. Robert Cornelius Quin, M.I.E.E., M.I.M.E., which has occurred with such suddenness as to cause a great shock to his many friends in municipal and other electrical circles. According to reports to hand he was on Monday last inspecting some granite quarries at Tamney, in County Donegal, with a view to making purchases for some of his electric tramway undertakings, when a tidal wave from the Atlantic swept him off the pier into the sea. Heroic efforts were made to save him, but without success. At the inquest a verdict of "Accidentally Drowned" was returned. Mr. Quin was in his 39th year, and those who had watched his success in electric lighting and traction during the past year or two had begun to see great things in store for him. About 17 years ago, after serving a pupilage with Mr. J. N. Shoolbred, he was connected with the equipment of the first municipal electricity works at Bradford. Thereafter, promotions to more responsible offices in municipal electric supply took him to Brighton and Blackpool. At the latter place there fell to his lot the substitution of the overhead trolley system for the 1882 conduit lines. It will be remembered that the Blackpool Corporation allowed him to engage in private consulting work in addition to his work under them, and after this arrangement had been in existence for a short time Mr. Quin resigned his connection with Blackpool altogether to enter into partnership with Mr. Speight, as Quin & Speight, consulting engineers, at Westminster. In addition to being consulting engineer for one or two provincial municipal authorities, he was promoter of electric traction undertakings, notably the Mid-Yorkshire tramways scheme, of which he was also engineer. His was a familiar figure, especially in the earlier years, at the annual conventions of the Municipal Electrical Association, before which he on several occasions read papers—indeed, only last July he was one of the speakers at the Newcastle meeting. He has also been among the recent speakers at the Institution of Electrical Engineers in London. He leaves a widow and five children, and to them in the terrible loss which has fallen upon them so suddenly and unexpectedly, we, on behalf of the general body of electrical men, tender our profoundest sympathy.

MR. ERNEST THOMPSON.—We regret to have to announce the death of Mr. Ernest Thompson, one of the joint managing directors of the firm of Nalder, Brothers & Thompson, Ltd., of 34, Queen Street, E.C., at the early age of 36, after a long and painful illness. Mr. Thompson was born in 1868. After entering the electrical engineering course at Finsbury College, under Prof. S. P. Thompson, where he gained a certificate for proficiency, he became a pupil at the Immisch Works, Chalk Farm, and on the completion of his term there, he obtained further practical experience at the works of Messrs. Siemens, of Charlton, and later on in the Brush Co.'s test room. In 1893 he became an assistant in Messrs. Nalder Bros. & Co.'s works, Red Lion Street, where he took charge in the test room of the ammeter and voltmeter department. This position he held until 1896, when the business of Nalder Bros. & Co. was divided, and Mr. Nalder purchased the ammeter, voltmeter and switchboard section of the business, and took Mr. Thompson into partnership with him, and started the firm of Nalder & Thompson. From that time onward Mr. Thompson was associated with the business of this firm in conjunction with Mr. Nalder. Everyone who met Mr. Thompson could hardly fail to be impressed by his restless energy, and the thorough and conscientious way in which he endeavoured to carry through anything to which he set his hand. His death will come as a shock to his many friends. He was first taken ill in Oct., 1902, and was ordered by his medical advisers to take a voyage; this he did, taking a trip round the world, visiting New Zealand, Australia, China, Japan, United States and Canada, where he made many new friends and met many old ones. It was hoped that this voyage would have benefited him, but apparently this was not to be, as he was only at work for three months before he had a relapse. Notwithstanding everything that was done in the way of the best advice and care, he passed away on Saturday, the 9th inst. He was an Associate Member of the Institution of Electrical Engineers.

As we go to press we learn that Mrs. Colebrook, wife of the chief electrical engineer at the Watford electricity supply works, passed away suddenly from heart failure on Wednesday evening. We beg to tender our sympathy with Mr. Colebrook in his bereavement.

The Institution of Civil Engineers.—At the meeting held on Tuesday, 12th inst., a paper on "The Electrical Re-Construction of the South London Tramways on the Conduit System," by Alexander Millar, Assoc.M.Inst.C.E., was submitted for discussion. The debate will be resumed next Tuesday.

Will.—Mr. A. C. Osler, of the firm of Messrs. F. & C. Osler, glass manufacturers, of 230, Broad Street, Birmingham, and of 100, Oxford Street, London, W., left estate of the gross value of £86,733 5s. 6d., the net personalty being sworn at £85,713 17s. 8d.

The Electrical Volunteers' Memorial.—The tablet erected at the head-quarters of the Corps of Electrical Engineers in memory of the members of that corps who died in South Africa during the late war, will be unveiled by Colonel Pitt, R.E., on the 27th inst., at 8.30 p.m. Ex-members of the corps and friends of the members who died in South Africa are especially invited morning dress).

Clyde Valley Power Scheme Arbitration.—An important arbitration took place this week in the Central Station Hotel, Glasgow, the parties being the British Westinghouse Electrical and Manufacturing Co. and the Brandon Bridge Building Co., Ltd., Motherwell. The matter in dispute is the Clyde Valley electrical power station at Motherwell, the buildings in connection with which were blown down during a storm in October last. The parties are at variance as to who is responsible for the construction being razed to the ground. Mr. David M. Westland, C.E., Edinburgh, is the sole arbiter.

The Cardiff Tramway Stoppage.—The man Parks, who was responsible for the stoppage of the electric tramway service, under circumstances already reported, has been sentenced to nine months' imprisonment, with hard labour.

Lecture. — At a meeting of the Glasgow University Engineering Society on the 28th inst., Mr. G. E. Windeler will read a paper on "Medium Speed Engines for Electrical Purposes."

Personal.—Mr. P. G. Gossler, general manager of the Montreal Light, Heat and Power Co., has resigned.

Appointments Vacant. — The Governing Body is inviting applications for the position of Principal at the South-Western Polytechnic, Chelsea (£600); two assistant superintendents of telegraphs are required for Ceylon (Rs. 3,500); a switchboard attendant is required for Motherwell electricity works; assistant in the C.T.C. (Exhibition Road) Electrical Engineering Dept. (£150); mains department assistant and station assistant-in-charge for West Ham (50s. each); mains superintendent for Wimbledon (£125 to £175); switchboard attendant for Kendal (25s.); engineer and tramways manager for Bexley Corporation (£300); chief assistant for Croydon (£200—£300).

Tunbridge Wells Supply.—The local papers reported that last Saturday there was a failure in the municipal electric supply system, but this statement was inaccurate, and it found its way into yesterday's *Electrical Times*. Mr. Boot, the city electrical engineer, telephones to us, just as we are going to press, asking us to contradict our contemporary's statement. What really occurred was the failure of the main fuse in one of the public buildings while the Mayor was delivering a speech. There was no interruption in the supply to other consumers. No longer need our esteemed exchange regard the matter as "wropped in mistry."

Horses Electrocuted.—It is reported that on Wednesday, at Brentford, two horses were killed through the breaking of an overhead trolley wire on the London United Tramways' system.

German Electrical Developments.—It is announced that the Berlin Allgemeine Electricity Co., which already has a share capital of £3,000,000, and which about a year ago entered into a community of interests with the Union Electricity Co., of the same city, for the pooling of profits for a period of 35 years, now proposes to increase its capital by the issue of new shares amounting to £1,150,000 for the purpose of completely absorbing the Union Co. and giving effect to agreements entered into with the United States General Electric Co. and the latter's European subsidiary (Thomson-Houston) companies. As bearing upon the matter, the *Frankfurter Zeitung* states that the General Electricity (Thomson-Houston) Co. has been formed, with a capital of 6,000,000 fr. (£240,000), which has been subscribed in equal halves by the Berlin Allgemeine Co. and the Thomson-Houston de la Méditerranée, which is the Italian company. The arrangement should have the effect of avoiding competition between the German and Italian interests in the future, while the absorption by the Union Co. by the Allgemeine Co. will bring the total capital of this group to £4,150,000.

A U.S.-German Turbine Deal.—An important American-German turbine deal is officially announced as having now been completed. It appears that the Allgemeine Electricity Co., of Berlin, has succeeded in concluding agreements with the European branch companies of the United States General Electric Co., the Curtis Turbine Co., Profs. Riedler & Stumpff, and the German Inventions Introduction Co. This fact now brings into immediate operation the principal agreement entered into between the Berlin Allgemeine Electricity Co. and the American General Electric Co., the Fort Wayne Electric Works Co., the Stanley Electric Manufacturing Co., the Eddy Electric Corporation, the General Incandescent Ark Light Co., and the Northern Electric Co. As a result of these agreements there has just been formed in Berlin the United Steam Turbine Co., which acquires the patents and rights in the matter of steam turbines devised by the American Curtis, and the Germans, Riedler & Stumpff. It will be seen from the above associations formed by the Berlin Allgemeine Co., that the relations concluded with the leading American electrical company go considerably beyond the avoidance of competition with the European Thomson-Houston manufacturing companies, and that the first step in advance is the promotion of rivals to the Parsons steam turbine, both for land and marine purposes. A further competitor is the Zoelly type, which is being introduced by the large Swiss engineering firm of Escher, Wyss & Co., of Zurich, the makers of the water turbines used at the Niagara Falls electric power station.

Bristol Fire.—We have received from Mr. H. W. Clothier, too late for insertion elsewhere, a letter referring to his article on the disaster at Bristol electricity works, an abstract of which is given elsewhere in this issue—unfortunately, the pressure on our space prevented the inclusion of the whole. Mr. Clothier states that the article was submitted to the Institution of Electrical Engineers, and was to have been read before a sectional meeting, but as an early date could not be arranged for, it was agreed instead to offer it to the technical press. The author hopes that a discussion will follow, and he will have pleasure in answering any questions arising out of the article. The latter, with the discussion, will afterwards be printed and distributed amongst engineers interested in the subject.

The following corrections should be made in the article:—P. 88, line 24, for "made" read "ordered;" line 25, for "40" read "44;" line 55, omit "loud." Fig. 2, omit the words "outer bus-bar under platform." Fig. 3, a cable rack should be shown under the platform, and the outer bus-bar omitted.

THE CENTRAL STATION ENGINEER.

ON Thursday last week at the Mersey Railway Power Station, Shore Road, Birkenhead, a presentation was made to Mr. J. F. MCMAHON, engineer-in-charge, who has resigned his position in order to take up an appointment with the Great Northern and City Railway Co., at Poole Street, London. Mr. J. Shaw, resident engineer to the company, presided; he congratulated Mr. McMahon on the very successful way he had managed the working of the station, knowing as he did full well that the position would be anything but a bed of roses. He also expressed regret at the loss of his valuable services, and was pleased to state that the week he was finishing with the Mersey company he had brought the station costs down to a record figure. He had left a hard task for his successor to improve upon these figures, as the "station costs are now as low as any in this country." The presentation consisted of a silver cigar case, cigarette case and match box, also a handsome purse for Mrs. McMahon. Mr. McMahon made a suitable response. Mr. McMahon is a brother of Mr. P. V. McMahon, of the City and South London Railway.

At the meeting of the Manchester City Council last week the appointment of Mr. S. L. PEARCE, as chief electrical engineer, was confirmed. The appointment was made subject to his devoting his whole time to the duties of his position, to the arrangements with Dr. Kennedy and Mr. Metzger, "and also to any other arrangements which the Corporation may from time to time make with consulting engineers; the position to be reviewed at the end of 12 months."

Mr. J. GRAY SCOTT, borough electrical engineer for Croydon, has resigned his position, having accepted the offer of the post of engineer and manager of the Hong Kong Electric Tramways at a salary of £1,500. It is felt that he will be a great loss to Croydon. Mr. Scott a few months ago married the daughter of Alderman D. B. Miller.

At a meeting on Monday evening, the Croydon County Council, acting on the recommendation of the Electricity Committee, appointed Mr. ALEXANDER C. CRAMB, chief assistant electrical engineer, to be borough electrical engineer, in the room of Mr. J. GRAY SCOTT. Mr. Cramb's salary will be £400, rising by annual increments of £50 to £600. It was decided to advertise for a successor to Mr. Cramb at a salary of £200, rising by annual increments of £25 to £300. At the same meeting the Council accepted Mr. E. J. SAUNDERS's tender for the erection of the building in connection with the extension of the generating station at £3,600.

Mr. H. A. NOTT is resigning the position of mains superintendent to the Wimbledon U.D.C., having been appointed assistant electrical engineer to the Sanitary Commissioners at Gibraltar.

Mr. W. H. GRIMSDALE, having resigned the post of electrical engineer and tramways manager, the Warrington Corporation Electricity and Tramways Committee has decided to separate the offices, and to appoint Mr. F. V. L. MATHIAS as electrical engineer. A tramways manager is to be appointed at a salary of £120 per annum, rising by £10 a year to £150.

NEW COMPANIES REGISTERED.

A.E.G. Electrical Co. of South Africa, Ltd. (79,666).—This company was registered on January 6th, with a capital of £50,000 in £5 shares, to carry on the business of electrical and mechanical engineers, electricians, suppliers of electricity for light, heat, motive-power and other purposes, manufacturers of, and dealers in, any apparatus, machinery, appliances, materials, substances and things capable of being used in connection with the generation, distribution, supply, regulation, control, accumulation and employment of electricity, constructors, owners and managers of railways, roads, tramways, mines, reservoirs, water-courses, generating stations, factories, and other public or private works and conveniences, manufacturers of and dealers in lamps, fittings, lamp-posts, electric light elevators, carbons, electromotive, gas water, steam, oil, petrol, and other engines and motors, lifts, pumps, cranes, turbines, water-wheels, and the like, &c., in South Africa or elsewhere. The first subscribers (each with one share) are:—J. Hottner, Weston House, Finchley Lane, Hendon, general manager; S. A. Simon, 30, Kenilworth Avenue, Wimbledon, engineer; C. Geistronger, 42, Petherton Road, N., clerk; G. Ambach, Kimberley, Arlington Road, Surbiton, assistant manager; A. Hirschberg, 34, Montague Place, Russell Square, N.W., clerk; P. Listner, 88, Holland Park Avenue, W., assistant manager lamp department; and M. Schlönberger, 27, Montague Street, Russell Square, W.C. No initial public issue. The number of directors is not to be less than three nor more than five; the first are Felix Deutsch, 22, Schiffbauerdamm, Berlin; Prof. Klinberger, 22, Schiffbauerdamm, Berlin; Frankz Deutsch, Warnford Court, E.C.; and C. F. de Nordwall, 12, Charing Cross Road, W.C.; remuneration, 10 per cent. of the net profits, divisible. Registered office, 125, Charing Cross Road, W.C.

ELECTRIC TRAMWAY ACCOUNTS.

Southport and Wallasey Municipal Tramways.

WE record this week an analysis of the returns of the Southport and Wallasey tramway undertakings for the period ending March, 1903. Both these concerns have to deal with, and depend largely on, holiday traffic.

The Southport Corporation lines during the year appear to have been suffering from competition, reduced earnings on routes where the fares were decreased, and bad weather, which, together, have had the effect of producing a considerable deficiency.

The Wallasey tramways report contains the first electrically worked year's results. Their route mileage is due to a considerable extension of the old company's 2·7 miles of track, and three routes are provided between Seacombe and New Brighton Ferries, covering a district on the Cheshire bank of the Mersey, which is very popular with Liverpudlians both for residential and holiday purposes.

The excellent earnings per car-mile, while, no doubt, explained by the above, are also due to the absence of appreciable competition, the Wirral railway having practically retired from business on their Seacombe—New Brighton line since the tramways were opened.

In this case a considerable balance has been earned on the year's working, and that after providing for depreciation and renewals.

Mr. Thos. J. Kendrew is the Southport tramways manager, and Mr. R. R. Greene, the Wallasey tramways manager.

GENERAL STATEMENT.

—	Southport.	Wallasey.
For 12 months ending	March 31, 1903	March 31, 1903
Length of route	8 miles	9 miles
Total length of track	10·7 miles	11 miles
Number of cars in use	(av.) 14	(av.) 23
Car-miles run	418,324	654,742
Passengers carried per annum ...	3,535,434	5,685,182
Capital expended to date	£116,8·2	£120,503
Total receipts	£16,387	£31,475
Working expenses	£11,231	£19,195
Gross profit	£5,155	£12,280
Income per car-mile	9·40d.	11·53d.
Working expenses per car-mile ...	6·44d.	7 03d.
Interest & sinking fund per car-mile	3 65d.	1·93d.
Total expenses per car-mile... ...	10·09d.	8 96d.
Profit or loss per car-mile	— ·69d.	+ 2 87d.
Cost of energy per car-mile... ...	1 87d.	2 43d.
Average fare per passenger... ...	1 098d.	1·30d.
Revenue per mile of route	£2,048	£3,497
Expenditure per mile of route ...	£1,408	£2,133
Total units used	458,472	979,133
Units used per car-mile	1·16	1·49

It will be seen from the above figures that the Wallasey undertaking possesses greater earning powers than the Southport line, while the latter is also handicapped by its abnormal financial charges, which, if on the same scale as Wallasey (below the average), would have enabled a surplus to be earned.

ANALYSIS OF WORKING EXPENSES.

—	Southport. Gross.	Southport. Per car-mile.	Wallasey. Gross.	Wallasey. Per car-mile.
Traffic expenses, including wages of employés, car-shed expenses, tickets, uniforms	£5,897	3·38d.	£8,190	3 02d.
Electrical energy	3,155	1 84 1.	6 630	2·43d.
Management and general expenses, including salaries, printing, stationery, insurance, law and sundry ...	677	·39d.	2,138	·77d.
Rent, rates and taxes ...	867	·50d.	280	·10d.
Repairs and Maintenance.				
Track...	187	·08d.	97	·03d.
Overhead equipment ...	132	·07d.	473	·17d.
Cars, &c.	316	·18d.	1,379	·50d.
Buildings	—	—	8	·01d.
Total working expenses ...	£11,231	6 44d.	£19,195	7·03d.
Percentage of working expenses to receipts	68 per cent.		61 per cent.	

The working expenses in both cases are good for small concerns, Wallasey's higher figure being partly due to extra cost of energy on gradients.

Both concerns purchase energy from the lighting departments, and the cost would, therefore, be higher than in the case of undertakings having their own tramway power station.

Curiously enough, in the case of Wallasey, the lighting department credits traction with 743,260 units only, or some 236,000 less than the tramways department say they used; we wonder whether the latter were treated as generously in the matter of charges. The respective percentages of working expenses, &c., are representative of the working conditions of the two systems.

PROFIT STATEMENT.

For year ending March 31st, 1903.	Southport.	Wallasey.
Interest	£3,493	£3,773
Sinking fund	2,885	1,508
Depreciation and renewals fund ...	—	4,500
Balance carried down	—1,223	2,499
Gross profit	£5,155	£12,280

As a result of the poor year at Southport, the financial charges, amounting to £6,378, more than absorbed the available gross profit, and, as a result, a debit balance of £1,223 was made. As previously mentioned, the financial charges are higher in proportion than many tramway undertakings, and they, in conjunction with other adverse circumstances, have tended to the poor result.

The Wallasey figures need little comment after our previous remarks. The combination of favourable circumstances led to a gross profit of £12,280, which was not much diminished by the deduction of the comparatively small financial charges. The department has wisely contributed a substantial amount to start a depreciation and renewals fund—and a substantial balance remains in hand.

CITY NOTES.

Blackpool, St. Annes, and Lytham Tramways Co.—This company is considering the advisability of reducing its capital from £150,000 to £125,000. It is proposed to be effected by a reduction of 2s. per share upon each preference share, and 4s. on each ordinary share, making them 18s. and 16s. respectively. It is further proposed that all preference dividends, and arrears of preference dividend, in respect of purchases prior to November 1st, 1903, shall be released and cancelled.

Dublin United Tramways Co.—The directors recommend a dividend at the rate of 6 per cent. per annum on the ordinary shares for the half-year ended December 31st last. The sum of £4,000 is set aside for reserve fund, £2,000 towards maintenance during current half-year, and £1,000 to accident insurance fund, leaving £6,775 to be carried forward.

Direct United States Cable Co.—The board has resolved upon the payment of an interim dividend of 3s. per share, free of income-tax, being at the rate of 3 per cent. per annum, for the quarter ending December 31st, 1903; such dividend to be payable on and after 30th inst.; setting aside £8,000 to reserve fund account, and carrying forward a balance of about £2,479. The transfer books will be closed from January 12th to 26th.

Globe Telegraph and Trust Co.—Quarterly dividend 2s. each on the ordinary shares.

South Wales Electrical Power Distribution Co.—An extraordinary meeting of the proprietors is to be held at the company's offices on Friday, 22nd inst., at 2.30 p.m., for the purpose of authorising the creation and issue of the second £50,000 debenture stock, which the company are now enabled to issue under the provisions of the Act, £300,000 of ordinary stock having been subscribed.

Stock Exchange Notice.—The Committee has appointed Wednesday, 20th inst., a special settling day in, and has granted a quotation to:—Buenos Aires Electric Tramways Co. (1901), Ltd.—£200,000 6 per cent. debenture stock.

Liverpool Overhead Railway Co.—A meeting of shareholders was held on Tuesday, at which it was resolved to create 6,000 preference shares of £10 each, bearing interest at 5 per cent. per annum. The main object is to provide means for the extension of the line, so as to connect with the Lancashire and Yorkshire Railway at Seaforth, on the Liverpool and Southport route. The estimated cost is £33,900.

STOCKS AND SHARES.

Wednesday Evening.

WAR markets continue. News, rumours and suggestions as to the situation in the Far East form the only food in the Stock Exchange, and all other influences are brushed aside by the one paramount consideration. Monetary conditions remain easy enough: those who wanted to lend upon bearer securities on Tuesday, complained that they could get no more than 4 to 4½ per cent. The dividend times are here, and there is plenty of capital awaiting employment. None of these things count at the moment. Every market hangs upon the Russo-Japanese difficulty, and, as we write, the war-cloud throws its sombre shadow over almost every department in the Stock Exchange.

Electrical railway stocks display a fresh weakness in the Central London trio as their principal feature. This is due to more pessimism as to the forthcoming distribution. The City and South London announcement is hourly expected; it is generally the pioneer of the Home Railway dividends. Metropolitans are 86, and Districts 34⅛. Great Northern and City Preferred Ordinary shares at 7⅛, and Brompton Ordinary (Speyers's Certificates) at 9½, are neglected. Central London 4 per cent. Debenture is 116½, *cum* the interest payable this Friday, January 15th; City and South London 4 per cent. Debenture stands at 110½, and here the dividend is not due until next May. Metropolitan Railway 4 per cent. Debenture, *ex* dividend, was done at 117½ a few days ago, and the stock is one of the cheapest to be found in the gilt-edged list, paying a shade over 3⅜ per cent. on the money.

Little or no change has been wrought in the Telegraph list by the prospects of an outbreak in the East. The Eastern Extension Co should be benefiting considerably by the increased business over its lines, but the price of shares remains quietly at 11¼. The only movement of importance during the week in this section has been a 10-point rise in Commercial Cable stock, the demand being American. The market on this side is too narrow for the fluctuations in price to have much interest for British investors. Anglo-American Deferred has receded ¼ upon the dividend estimates to which we referred last week. None of the Trust varieties have moved; the Globe Telegraph and Trust announces dividends of 2s. and 3s. upon its Ordinary and Preference shares respectively.

National Telephone issues maintain their prices, although the third Preference have lost 2s. 6d. Oriental Preference are also a trifle easier at the middle. It is a pity that the official quotations for both telegraphs and telephones should be so wide as to furnish little more than a misleading guide to the market. In the electricity supply section the same drawback also exists, perhaps in a lesser degree, but still sufficiently badly to warrant shareholders remarking upon the unnecessary margin between buying and selling prices as set forth in the list.

City of London Ordinary are ¼ higher, support being given on the possibility of a better dividend for the final half of last year. Several other lighting companies, as we were pointing out some weeks ago, are expected to declare higher dividends, notably Bromptons and Westminsters, but this consideration is lost in that of the political outlook. St. James's Preference have hardened 10s., and London Electric Preference are up 5s. Unusual interest attaches to the Metropolitan announcement and to the South London's report, owing, of course, to the complications in Marylebone and the County Council's tramway requirements respectively. Blackheath shares are in quiet request, and so is the Debenture stock, although the prices show no change. It is said that the Charing Cross and Strand Co. has been doing new business at the rate of about 52,000 lamps for 1903. To glance at the provincial list for a moment, we may record that Bournemouth and Poole Ordinary are 13, and the Preference fell to 10 the other day. The Second Preference (which are the subject of demand in a well-known shop window in Bournemouth) have a nominal quotation of 11½, but are scarce. Oxfords are 5½, Hove 8, Folkestones 5⅝, and Bromley (Kent) Debenture 101½. Of the "further-away" shares, Havana Electrics stand at their paid-up value of £8, Calcutta Electrics are 7, and Electric Lighting of Australia (whose secretary, Mr. Lane, was attacked by the youth with the hatchet) keep about 4 for the Preference shares, which have had no dividend since last February.

Crompton Debenture dropped 2½ to 98½, while British Westinghouse Preference, after touching 3⅛, have recovered to 4¼. The buying has the appearance of what the financial journalist loves to call inspired. A reason in this case is manifestly furnished by the coming issue of new shares at 5, for what shareholder would be willing to apply at that price if he can get the senior issue 15s. to a pound cheaper in the market? General Electrics have lost ¼ upon the depression amongst investment descriptions.

British Electric Tractions display no alteration. London United Preference changed hands at 11½ on Tuesday, and British Columbia Electric Deferred at 79⅜, the Preferred stock being about 92½. Buenos Ayres and Belgrano continue a steady market, the Ordinary shares at 3⅛, the "A" and "B" Preferences at 5¼ and 5 respectively. Anglo-Argentines are 4⅞, and Cape Electrics 1⅝. Amongst miscellaneous shares, Telegraph Constructions at 34½ are £1 easier.

Business in the New York Stock Exhange having been badly hampered the other day by a fire that affected the electrical working of the tape machines, some curiosity has been expressed as to what might be the consequence of a similar accident on this side. The cynical say that a whole month's enforced holiday would do no harm to the Stock Exchange in the present condition of markets.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1900.	1901.	1902.	Closing Quotations Jan. 6th.	Closing Quotations Jan. 13th.	Business done week ended Jan. 13th, 1904. Highest	Lowest
67,100	African Direct Telegraph, 4 % Debs.	100	..	..	..	98 —102 xd	98 —102	..	..
25,000	Amazon Telegraph Co.'s shares, Nos. 1 to 25,000	10	..	..	..	2½ — 3½	2½ — 3½	..	..
119,700£	Do. do. 5 % Debs., Nos. 1 to 1,250 Red.	100	..	..	..	70 — 80	70 — 80	..	..
738,840	Anglo-American Telegraph	Stock	3½%	6¼s.	6 6/8	49 — 52	49 — 52	..	..
3,105,580	Do. do. do. 6 % Pref.	Stock	6 %	6 %	6 %	92 — 94	92 — 94	94	93
3,105,580	Do. do. do. Deferred	Stock	5s. %	2s.	1/-	7⅞ — 8⅛	7⅞ — 8	7 13/16	7⅞
44,000	Chili Telephone, Nos. 1 to 44,000	5	5 %	5 %	6 %	4¾ — 5¼	4¾ — 5¼	..	..
13,333,300$	Commercial Cable	$100	8 %	8 %	8 %	160 —170 xd	175 —185	..	..
1,841,209	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	..	..	..	88 — 92 xd	88 — 92	90	89⅞
16,000	Cuba Telegraph	10	4½%	4 %	6¾%	7 — 8	7 — 8	7⅞	..
6,000	Do. 10 % Pref.	10	..	..	..	16 — 17	16 — 17	..	..
12,931	Direct Spanish Telegraph	5	4 %	4 %	4 %	2½ — 3½	2½ — 3½	..	..
6,000	Do. do. 10 % Cum. Pref.	5	..	..	..	7 — 8	7 — 8	7⅞	..
20,000	Do. do. 4½ % Debs.	50	..	..	..	98 —101⅝ xd	100 —103 ⅝	..	..
60,710£	Direct United States Cable	20	8½%	8½%	8½%	10 — 10½	10 — 10½	10⅛	..
85,800	Direct West India Cable, 4½% Reg. Deb., within Nos. 1 to 1,200, Red.	100	..	..	..	98 —101 xd	98 —101	..	..
4,000,000	Eastern Telegraph, Ord. Stock	Stock	7 %	7 %	7 %	121 —126	121 —126	123	..
1,955,555	Do. 8½ % Pref. Stock	100	..	..	..	87 — 90	87 — 90	..	..
1,584,645	Do. 4 % Mort. Deb. Stock Red.	Stock	..	..	..	105 —108	105 —108	..	..
800,000	Eastern Extension, Australasia, and China Telegraph	10	7 %	7 %	7 %	11 — 11½	11 — 11½	11¼	11
320,000£	Do. 4 % Deb. Stock	Stock	..	..	..	106 —109	106 —109	106½	..
800,000	Eastern & South African Tele., 4% Mt. Db., Nos. 1 to 8,000, red. 1909	100	..	..	..	99 —102	99 —102	100½	99½
200,000£	Do. do. 4 % Reg. Mort. Debs. (Mauritius Sub.) 1 to 8,000	25	..	..	..	99 —102	99 —102	..	..
180,227	Globe Telegraph and Trust	10	5½%	5½%	..	8⅝ — 8¾	8⅝ — 8¾	8⅝	8 7/16
180,042	Do. do. 6 % Pref.	10	..	..	..	12¼ — 13	12¼ — 13	12 13/16	12⅝
150,000	Great Northern Telegraph, of Copenhagen	10	15 %	15 %	12½%	24½ — 25½	24½ — 25½	..	..
58,700	Halifax and Bermudas Cable, 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	..	..	..	98 —101	98 —101	..	..
17,000	Indo-European Telegraph	25	10 %	10 %	10%	37 — 40	37 — 40	..	..
100,000£	London Platino-Brazilian Telegraph, 6 % Debs.	100	..	..	..	98 —102	98 —102	..	..
1,983,333	National Telephone, Pref. Stock	100	5 %	5 %	6 %	102 —104	102 —104	103½	102
1,966,667	Do. do. Def. Stock	100	..	..	4½%	77 — 80	77 — 80	77¼	77
15,000	Do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	13 — 14	13 — 14	..	..
15,000	Do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	13 — 14	13 — 14	..	..
2,250,000	Do. do. 5 % Non-cum. 3rd. Pref., 1 to 250,000	5	5 %	5 %	5 %	5½ — 5⅝	5 — 5½	5⅛	..
000,000£	Do. do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	95 — 97 xd	95 — 97	..	..
600,000	Do. do. 4 % Deb. Stock Red.	100	4 %	4 %	4 %	100 —102 xd	100 —102	..	..
179,313	Oriental Telephone and Elec. Nos. 1 to 171,504, fully paid	1	6 %	6 %	6 %	⅝ — 1	⅝ — 1	..	..
50,000	Do. do. do. 6 % Cum. Pref.	1	..	..	..	.. — ..	1 — 1⅛	..	..
100,000£	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000	100	..	..	..	97 —100 xd	97 —100	..	..
11,839	Reuter's	5	5 %	5 %	..	6½ — 7½	6¼ — 7¼	..	..
5,303	Submarine Cables Trust	Cert.	..	..	..	118 —123	118 —123	119	..
58,000	United River Plate Telephone	5	7 %	7 %	7 %	5¼ — 6 xd	5¼ — 6	..	..
40,000	Do. do. 5 % Cum. Pref., Nos. 1 to 40,000	5	..	..	..	4½ — 5¼xd	4½ — 5¼	..	..
179,947£	Do. do. 5 % Debs.	Stock	..	..	..	102 —105 xd	102 —105	..	..
15,609	West African Telegraph, Shares	10	..	..	2 %	5 — 6	5 — 6	..	..
150,000£	West Coast of America, 4% Debs., 1 to 1,500 guar. by Bras. Sub. Tel.	100	..	..	..	95 — 98 xd	95 — 98	..	..
267,980	Western Telegraph, Ltd., Nos. 1 to 207,980	10	7 %	7 %	7 %	11½ — 12½xd	11½ — 12½	12	11 13/16
75,000£	Do. do. 5 % Debs. 2nd series, 1906	100	..	..	..	99 —102 xd	99 —102	..	..
400,000	Do. do. 4 % Deb. Stock Red.	100	..	..	..	98 —101 xd	98 —101	..	..
88,321	West India and Panama Telegraph	10	½%	..	..	⅜ — ½	⅜ — ½	..	..
84,563	Do. do. do. 6 % Cum. 1st Pref.	10	..	..	..	6 — 6¼	6 — 6¼	6⅛	6
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	..	..	..	4½ — 5½	4½ — 5½	..	..
80,000£	Do. do. do. 5 % Debs., Nos. 1 to 1,800	100	..	..	..	99 —102 xd	99 —102	99	..

ELECTRICAL RAILWAY, MANUFACTURING AND INDUSTRIAL COMPANIES.

20,000	British Aluminium 7 % Cum. Pref.	10	..	..	..	4½ — 5¼	4½ — 5½	..	..
800,000£	Do. do. 5% 1st Mort. Deb. Stock Red.	Stock	..	..	..	88 — 92	88 — 92	..	..
100,000	British Electric Traction	10	9 %	9 %	8 %	11½ — 11⅝	11½ — 11⅝	11⅝	11½
100,000	Do. do. 6 % Cum. Pref.	10	..	..	..	11½ — 11⅝	11½ — 11⅝	11 11/16	11⅝
600,000£	Do. do. 5 % Perpetual Debenture Stock	Stock	..	..	..	120 —123	120 —123	..	..
100,000	British Insulated and Helsby Cables	5	15 %	10 %	10 %	6 — 6¼	6 — 6¼	..	..
100,000	Do. do. 6 % Cum. Pref.	5	..	..	..	5¼ — 5⅜	5¼ — 5⅜	..	..
50,000	Do. do. 4½ % 1st Mort. Deb. Red.	100	..	..	..	102 —107 xd	102 —107	..	..
50,000	¶Browett, Lindley & Co., Ord.	£1	8 %	Nil	..	⅜ — ½	⅜ — ½	..	..
50,000	¶ Do. do. 6 % Cum. Pref.	£1	6 %	6 %	..	14/6 to 15/6	14/6 to 15/6	..	..
105,731	Brush Electrical Engineering, Ord., 1 to 105,731	2	5 %	Nil	Nil	¾ — 1⅛	¾ — 1⅛	1	..
150,000	Do. do. Non-cum. 6 % Pref.	2	6 %	3 %	6 %	1⅛ — 1⅜	1⅛ — 1⅜	..	..
125,000£	Do. do. 4½ % Perp. Deb. Stock	Stock	..	..	..	97 —100	97 —100	..	..
125,000£	Do. do. 4½ % Perp. 2nd Deb. Stock	Stock	..	..	..	75 — 80 xd	75 — 80	..	..
85,000	Callender's Cable Construction shares	5	15 %	20 %	15 %	11 — 12	11 — 12	..	..
40,000	Do. do. do. 5 % Cum. Pref.	5	..	..	..	5¼ — 5⅜xd	5¼ — 5⅜	5½	5¼
90,000£	Do. do. do. 4½ % 1st Mort. Deb. Stock Red.	Stock	..	..	..	106 —110	104 —108	..	..
1,860,014	Central London Railway, Ord. Stock	Stock	..	4 %	4 %	93 — 95	91 — 94	95	92½
494,093	Do. do. 4 % Pref. Stock	Stock	..	4 %	4 %	99 —102	98 —101	99½	98½
494,998	Do. do. Def. do.	Stock	..	4 %	4 %	93 — 96	91 — 94	92½	..
1,330,000	City and South London Railway	Stock	1½%	2 %	3½%	47 — 50	47 — 50	48½	47
85,000	Crompton & Co., Nos. 1 to 85,000	8	8 %	7½%	5 %	1¾ — 2¼	1⅞ — 2¼	..	..
100,000£	Do. 5 % 1st Mort. Reg. Debs., to 900 of £100, and 901 to 11,000 of £50 red.	..	..	..	..	99 —103	97 —109	..	..
99,261	Edison & Swan United Elec. Light, "A" shares, £8 paid, 1 to 99,261	5	2½%	Nil	..	0 — ¼	0 — ¼	..	..
17,139	Do. do. "A" shares, 01—017,139	5	2½%	Nil	..	¼ — 1⅛	¼ — 1⅛	..	..
844,023£	Do. do. 4 % Deb. Stock Red.	100	..	..	..	71 — 76 xd	71 — 76	..	..
100,000£	Do. do. 5 % 2nd Deb. Stock Prov. Certs. all pd.	100	..	..	..	76 — 81	76 — 81	..	..
112,100	Electric Construction, 1 to 112,100	2	6 %	6 %	6 %	1⅝ — 1⅞	1⅝ — 1⅞	..	..
31,390	Do. do. 7 % Cum. Pref., 1 to 31,390	2	..	..	..	2¾ — 3	2¾ — 3	..	..
82,500£	Do. do. 4 % Perp. 1st Mort. Deb. Stock	Stock	..	..	..	98 —101	98 —101	..	..
25,000	General Electric Co. (1900), 5 % Cum. Pref.	10	5 %	5 %	5 %	9⅜ — 10⅛	9⅜ — 10	..	..
200,000	Do. do. 4 % Mort. Deb.	Stock	..	..	..	95 — 98	95 — 98	..	..
85,000	Henley's (W. T.) Telegraph Works, Ord.	5	20 %	20 %	20 %	13½ — 14½	13½ - 14½	14 1/16	13 11/16
85,000	Do. do. 4½ % Pref.	5	4½%	..	..	5 — 5⅛	5 — 5⅛	5 1/16	5
48,050	Do. do. 4½ Mort. Deb. Stock	Stock	..	..	..	108 —112	108 —112	..	..
50,000	India-Rubber, Gutta-Percha & Telegraph Works	10	10 %	10 %	10 %	18 — 19 xd	18 — 19	..	..
800,000£	Do. do. do. 4 % 1st Mort. Deb.	100	..	..	..	100 —103	100 —103	..	..
37,500	†Liverpool Overhead Railway, Ord.	10	3½%	1½%	1½%	4⅜ — 5	4⅜ — 5	..	..
10,000	† Do. do. Pref. £10 paid	10	..	1 %	..	10¼ — 10⅜	10½ — 10⅝	..	..
37,350	Telegraph Construction and Maintenance.	12	17½%	20 %	20 %	34 — 37	33 — 36	35⅜	34
150,000£	Do. do. 4 % Deb. Bds., Nos. 1 to 1,500 Red. 1909	100	..	..	..	100 —103 xd	100 —103	..	..
640,000£	Waterloo & City Railway, Ord. Stock	100	3 %	3 %	3⅛%	91 — 94	91 — 94	..	..

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ From Manchester Share List.

Bank rate of discount 4 per cent. (September 3rd, 190

SHARE LIST OF ELECTRICAL COMPANIES (*continued*).—ELECTRICITY SUPPLY COMPANIES.

Present issue.	NAME.	Stock or Share.	Dividends for the last three years. 1900.	1901.	1902.	Closing Quotations Jan. 6th.	Closing Quotations Jan. 13th.	Business done week ended Jan. 13th, 1904. Highest.	Lowest
100,000	Blackheath and Greenwich Dist. Electric Light, Ord.	‡ £1	..	..	..	⅝ — ¾	⅝ — ¾	..	..
100,000	Do. 4½% 1st Deb. Stock, Prov. Certs.	100	..	..	..	114 —117	114 —117	..	..
20,000	Brompton & Kensington Electric Light Sup., Ord., 1 to 20,000	5	6 %	8 %	8 %	10 — 10½	10 — 10½	..	..
20,000	Do. do. 7 % Cum. Pref.	5	..	..	..	9⅜ — 10⅛	9⅜ — 10⅛	..	..
50,000	Charing Cross and Strand Electricity Supply	5	9 %	10 %	10 %	8½ — 9⅜	8½ — 9⅜	9½	9
70,000	Do. do. do. 4½% Cum. Pref.	5	..	..	..	5⅛ — 5⅜	5⅛ — 5⅜	..	..
40,000	Do. do. "City Undertaking" 4½% Cum. Pref.	5	..	..	..	4⅜ — 5 xd	4⅜ — 5	..	..
250,000	Do. do. 4 % Deb. Stock Red.	100	..	..	..	103 —105	103 —105	..	..
44,436	*Chelsea Electricity Supply, Ord.	5	5⅓%	4 %	4⅓%	5⅛ — 6	5⅛ — 6	..	..
150,000‡	Do. do. % Deb. Stock Red.	Stock	..	..	..	105 —108 xd	105 —108	..	..
70,595	City of London Electric Lighting, Ord. 40,001—110,595	10	0 %	5 %	5 %	10 — 10⅛	10⅛ — 10⅜	10⅜	10½
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	..	..	13 — 14	13 — 14	13¼	..
400,000‡	Do. 5 % Deb. Stock, Scrip. (iss. at 115) all paid	..	..	..	..	121 —126 xd	121 —126	..	..
800,000	Do. 4½% 2nd Deb. Stock, Prov. Certs., all paid	100	..	..	..	101 —104 xd	101 —104	..	..
40,000	County of London & Brush Prov. Electric Lighting, Ord. 1—40,000	10	4 %	4 %	4 %	7⅛ — 8⅛	7⅛ — 8⅛	..	..
20,000	Do. do. do. 6 % Pref., 40,001—60,000	10	..	..	..	11⅛ — 12⅛	11⅛ — 12⅛	11⅞	11½
400,000‡	Do. do. 4½% Deb. Stock	..	..	..	..	107 —110 xd	107 —110	107	..
250,000	Do. do. 4½% 2nd Deb. Stock	Stock	..	..	..	99 —102	99 —102	101¼	100
50,000	Edmundson's Electric Corporation, Ord. Shares	5	7 %	7 %	7 %	6 — 6⅛	6 — 6⅛	6⅛	6⅛
80,000	Do. do. 6 % Cum. Pref.	..	..	..	..	6 — 6⅝	6 — 6⅝	6 7/16	..
140,000	Do. do. 4½% 1st Mort. Deb. Stock	100	..	..	..	104 —107	104 —107	106	..
21,000	Kensington and Knightsbridge Electric, Ord.	5	12 %	10 %	10 %	10⅛ — 11⅛	10⅛ — 11⅛	..	..
90,000	Do. do. do. 4 % Debenture Stock	Stock	..	..	..	101 —104	101 —104	..	..
110,000	London Electric Supply Corporation, Limited, Ord.	3	..	..	..	1⅜ — 2⅛	1⅜ — 2⅛	..	..
49,840	Do. do. do. 6 % Pref.	5	..	..	..	5 — 5⅛	5⅛ — 5⅜	5⅛	..
250,000‡	Do. do. do. 4 % 1st Mort. Deb. Stock Red	Stock	..	..	..	97 —100	97 —100	98½	..
100,000	Metropolitan Electric Supply, 1 to 100,000	10	6 %	6¼%	7¼%	17 — 18	17 — 18	17½	17 1/16
71,106	Do. do. 4½% Cum. Pref. 1—71,106, £3 paid	5	..	..	..	5⅛ — 5⅜	5⅛ — 5⅜	5 7/16	5⅜
220,000‡	Do. do. 4½% 1st Mort. Deb. Stock	..	..	..	..	109 —113 xd	109 —113	110½	110
250,000‡	Do. do. 3½% Mort. Deb. Stock Red	Stock	..	..	..	95 — 98 xd	95 — 98	..	..
10,852	Notting Hill Electric Lighting	10	7 %	6 %	6 %	12¼ — 13¼	12¼ — 13¼	..	..
40,000	St. James' and Pall Mall Electric Light, Ord.	5	14½%	14½%	14½%	14½ — 15½	14½ — 14⅞	14⅞	14⅝
20,000	Do. do. do. 7 % Pref. 20,081 to 40,080	5	..	..	..	7⅞ — 8⅛	8 — 9	8¼	8⅛
150,000‡	Do. do. do. 3½% Deb. Stock Red	100	..	..	..	98 —101 xd	98 —101	..	..
12,000	Smithfield Markets Electric Supply, Ord.	5	..	..	2½%	3 — 3½	3 — 3½	..	..
50,000	Do. do. do. 4 % Deb. Stock	Stock	..	..	..	— —	85 — 90	..	..
65,000	South London Electricity Supply, Ord.	5	..	..	1½%	3⅛ — 3⅜	3⅛ — 3⅜	..	..
80,000	Urban Electric Supply, Ord.	5	..	..	..	4⅜ — 5⅛	4⅜ — 5⅛	..	..
80,000	Do. do. 5 % Cum. Pref.	5	..	..	..	4⅜ — 5⅛	4⅜ — 5⅛	..	..
110,000	Westminster Electric Supply, Ord.	5	10½%	10½%	12 %	12 — 13	12 — 13	12⅜	1·½
28,141	Do. do. 5 % Cum. Pref.	5	..	..	..	6 — 6¼	6 — 6¼	..	..

*Subject to Founders Shares. ‡ Unless otherwise stated all shares are fully paid.

MARKET QUOTATIONS, Wednesday, January 13th.

	CHEMICALS, &c.		Latest Price.	Week's Inc. or Dec.
a	Acid, Hydrochloric	per cwt.	5/-	..
a	,, Nitric	per cwt.	22/-	..
a	,, Oxalic	per cwt.	32/-	..
a	,, Sulphuric	per cwt.	5/6	..
a	Ammoniac, Sal	per cwt.	42/-	..
a	Ammonia, Muriate (crystal) ..	per ton	£33 10	..
a	,, ...	per ton	£30	..
a	Bleaching powder	per ton	£4 10	..
a	Bisulphide of Carbon ..	per ton	£15	..
a	Borax	per ton	£13	..
a	Benzole (90%)	per gal.	7/-	..
a	,, (50/90%)	per gal.	5/6	..
a	Copper Sulphate	per ton	£20	..
a	Lead, Nitrate	per ton	£24	..
a	,, White Sugar	per ton	£31	..
a	,, Peroxide	per ton	£27 10	..
a	Methylated Spirit	per gal.	2/6	..
a	Naphtha, Solvent (90% a 160° C).	per gal.	5/6	..
a	Potash, Bichromate, in casks ..	per lb.	8d.	..
a	,, Caustic (75/80%) ..	per ton	£24	..
a	,, Bisulphate	per ton	£35	..
a	Shellac	per cwt.	226/-	..
a	Sulphate of Magnesia ..	per ton	£4 10	..
a	Sulphur, Sublimed Flowers ..	per ton	£6 10	..
a	,, Recovered	per ton	£5 10	..
a	,, Lump	per ton	£5	..
a	Soda, Caustic (white 70%) ..	per ton	£10 15	..
a	,, Crystals	per ton	£3	..
a	,, Bichromate, casks	per lb.	2½d.	..
	METALS, &c.			
b	Aluminium Ingots, in ton lots ..	per ton	£130	..
b	,, Wire, in ton lots ..	per ton	£168	..
b	,, Sheet, in ton lots ..	per ton	£166	..
p	Babbitt's metal ingots	per ton	£48 to £130	..
e	Brass (rolled metal 2" to 12") basis	per lb.	7d.	⅛d. inc.
e	,, Tube (brazed)	per lb.	9d.	⅛d. inc.
e	,, ,, (solid drawn)	per lb.	7⅛d.	⅛d. inc.
e	,, Wire, basis	per lb.	7⅛d.	⅛d. inc.
e	Copper Tubes (brazed) ..	per lb.	9⅛d.	⅛d. inc.
e	,, ,, (solid drawn)	per lb.	9⅛d.	⅛d. inc.
g	Copper Bars (best selected ..	per ton	£73	£2 inc.

	METALS, &c. (*continued*).		Latest Price.	Week's Inc. or Dec.
g	Copper Sheet	per ton	£73	£2 inc.
g	,, Rod	per ton	£73	£2 inc.
e	,, (Electrolytic) Bars ..	per ton	£63	..
e	,, Sheets ..	per ton	£73	..
e	,, ,, Rod ..	per ton	£75	..
e	,, ,, H.C. Wire	per lb.	7⅞d.	⅛d. inc.
f	Ebonite Rod	per lb.	3/8	..
f	,, Sheet	per lb.	8/-	..
n	German Silver Wire	per lb.	1/6	..
h	Gutta-percha fine	per lb.	8/-	..
h	India-rubber, Para fine	per lb.	3/11½ to 4/0½	inc.
i	Iron, Charcoal Sheets	per ton	£18	..
i	,, Pig (Cleveland warrants)	per ton	42/9	..
i	,, Forgings, according to size	per ton	From £11	..
i	,, Scrap, heavy	per ton	47/6 to 50/-	..
i	,, Wire, galvanised No. 8 ..	per ton	£9 15	..
g	Lead, English Ingot	per ton	£12	5/- inc.
g	,, ,, Sheet	per ton	£13	..
m	Manganin Wire No. 28	per lb.	8/-	..
g	Mercury	per bot.	£8 5	..
d	Mica (in original cases) small ..	per lb.	4d. to 1/6	..
d	,, ,, ,, medium	per lb.	2/6 to 3/9	..
d	,, ,, ,, large ..	per lb.	4/- to 7/9	..
p	Phosphor Bronze, plain castings	per lb.	1/- to 1/2½	..
p	,, ,, rolled bars & rods	per lb.	1/- to 1/3	..
p	,, ,, strip & sheet	per lb.	From 1/1	..
o	Platinum	per oz.	£4	..
p	Silicium Bronze Wire	per lb.	9d. to 11d.	..
i	Steel, Magnet, acc'd'g to desc'p'n	per ton	£68	..
i	,, ,, in bars		£15 to £40	..
g	Tin, Block	per ton	£136 10 to £137 10	£3 inc.
g	,, Foil	per lb.	1/6	..
n	,, Wire, Nos. 1 to 16	per lb.	1/8	..
p	White Anti-friction Metals— "White Ant" brand ..	per ton	£42 to £62	..
f	Yarns, 2/10s Grey Cotton, on sp'ls	per lb.	8d.	..
j	,, 6 les. Flax	per lb.	5½d.	..
j	,, 8 ply 10 lbs. Russian ..	per lb.	4½d.	..
j	,, 10 lbs. Russian, single ..	per lb.	4½d.	..
j	,, 180 lbs. Jute rove ..	per ton	£11	..
k	Zinc, Sh't (Vieille Montagne bnd.)	per ton	£24 15	£1 inc.

Quotations supplied by Messrs.:—*a* G. Boor & Co.; *b* The British Aluminium Co., Ltd.; *c* Thos. Bolton & Sons., Ltd.; *d* F. Wiggins & Sons.; *e* Frederick Smith & Co.; *f* India-Rubber, G.P. and Teleg. Works Co., Ltd.; *g* James & Shakspeare; *h* Edward Till & Co.; *i* Bolling & Lowe; *j* Walter H. Hindley and Co., Ltd.; *k* Morris Ashby, Ltd.; *m* W. T. Glover & Co., Ltd.; *n* P. Ormiston & Sons; *o* Johnson, Matthey & Co., Ltd.; *p* The Phosphor Bronze Co., Ltd.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RETURNS

	Locality.	Week ending	Receipts for the week. £	£*	No. wks.	Total to date. £	£*	Miles open.	*
	Aberdeen	Jan. 9	1,240	+420	32	39,858	+ 7,312	10	—
	Birmingham ..	,, 9	5,046	+123	2	10,352	+ 351	3½	—
	Bournemouth ..	,, 6	857	—	—	—	—	10½	—
	Blackburn	,, 8	722	+ 46	—	35,096	+ 1,383	18½	—
	Blackpool	Dec. 24	287	— 18	—	37,603	— 159	8½	—
	,, —Fleetw'd	Jan. 9	188	— 4	2	250	— 48	7½	—
	,, —Lytham	,, 7	135	+111	10	1,454	+ 929	7½	—
	Bolton	,, 10	1,666	+105	—	75,517	+ 8,424	25	—
	Bradford	—	—	—	—	—	—	41	+4
	Brighton	,, 10	743	—	—	37,754	—	7½	—
	Bristol	,, 8	4,448	+102	—	—	—	28	—
Brit. Elec. Trac. Co.	Devonport ..	,, 1	457	+ 79	52½	24,268	+ 1,844	5	—
	Dudley—Sto'rb'ge	,, 1	865	+ 66	52½	43,549	+ 3,852	18½	—
	Gateshead ..	,, 1	1,008	+ 86	52½	46,272	+ 5,494	10½	+ ¾
	Gr'n'k—Pt. Glsgw	,, 1	520	— 2	52½	28,398	+ 2,328	7½	—
	Hartlepool ..	,, 1	293	+ 45	52½	14,175	+ 994	6½	+2
	Middleton ..	,, 1	278	+ 6	52½	16,359	+ 1,951	8½	—
	Oldham—Ashton	,, 1	543	+ 14	52½	29,582	+ 1,643	8	—
	Potteries	,, 1	1,549	+ 3	52½	83,559	+ 3,722	28½	—
	Southport	,, 1	239	— 19	52½	16,109	+ 2,710	5½	—
	South Staffs. ..	,, 1	1,186	+389	52½	48,636	+ 9,288	21½	—
	Swansea	,, 1	554	+ 61	52½	27,192	+ 2,192	5½	—
	Wolverhampton ..	,, 1	423	+ 31	52½	20,285	+ 7,627	10½	+8
	Yorks. Wool Dist.	,, 1	605	—	45½	18,267	—	6	—
	Miscellaneous ..	,, 1	1,686	—	—	102,556	—	—	—
	Burnley	,, 9	815	+140	—	—	—	7½	—
	Burton-on-Trent ..	,, 10	294	—	23	8,156	—	8½	—
	Cardiff	,, 8	1,782	+199	—	78,719	+20,552	1	—
	Chatham & District	,, 7	495	+ 97	1	495	+ 44	8·68	—

* Compared with the corresponding period of 1903.

	Locality.	Week ending	Receipts for the week. £	£*	No. wks.	Total to date. £	£*	Miles open.	*
	Cork	Jan. 7	415	— 41	1	415	— 41	9	—
	Dover	,, 9	172	— 11	2	294	— 45	3	—
	Dublin	,, 8	4,402	+ 67	2	5,042	+ 24	47	+ ½
	East Ham	,, 9	584	+102	—	27,363	+ 7,715	5	+ ½
	Glasgow	,, 9	14,619	+2594	32	439,305	+45,685	69½	+7½
	Halifax (2 weeks) ..	Dec. 30	2,376	+ 85	39	53,653	+ 5,827	31½	+1½
	Huddersfield ..	Jan. 9	1,093	+ 80	—	—	—	—	—
	Hull	,, 9	2,037	+275	41	77,732	+ 5,290	18	+2½
	Ilkeston	,, 9	106	—	—	—	—	4	—
	Ipswich	,, 9	340	—	—	2,033	—	9	—
	Isle of Thanet ..	,, 9	222	— 33	1	222	— 33	10½	—
	Leeds	,, 9	4,795	+224	—	225,523	+13,630	41	—
	Liverpool	,, 2	9,696	— 11	1	9,696	— 11	103	—
	London C. C. ..	,, 9	9,326	+1234	40½	403,144	+72,279	39½	—
	Manchester	,, 9	10,749	+2569	—	477,714	+265,387	72	—
	Newcastle	,, 9	3,468	+523	—	—	—	17	—
	Portsmouth	,, 9	1,371	+ 51	—	72,719	+ 5,689	14½	—
	Salford	,, 4	3,984	+676	—	153,565	+43,985	30	—
	Sheffield	,, 8	4,620	+511	1	4,620	+ 311	31½	+4
	Southampton ..	Dec. 17	814	+ 17	—	—	—	16½	—
	Southend-on-Sea ..	Jan. 6	189	+ 19	40	18,226	+ 2,080	8	—
	Sunderland	,, 10	1,035	+126	41	50,327	+ 2,328	20	+3
	Tyneside	,, 6	253	+ 23	1	253	+ 23	8·9	+ ·43
	Wolverhampton ..	,, 10	392	— 4	—	—	—	9½	—
	Cen. London Rly. ..	,, 9	7,054	+ 87	2	13,645	— 5	6	—
	City & S. Lon. Rly.	,, 10	3,133	—278	2	6,405	— 442	6½	—
	Dublin—Lucan Rly.	,, 10	126	— 4	1	126	— 4	6½	—
	L'pool Overh'd Rly.	,, 10	1,598	+ 96	2	3,161	+ 163	6½	—
	Mersey Railway ..	,, 9	1,450	+383	2	3,093	—	4½	—

INSTITUTION OF ELECTRICAL ENGINEERS.

THE CITY AND SOUTH LONDON RAILWAY: WORKING RESULTS OF THE THREE-WIRE SYSTEM APPLIED TO TRACTION, &c.

By Peter Valentine McMahon, Member.

(*Abstract of Paper read December 17th, 1903.*)

(*Concluded from page 75.*)

The second set of tests was taken on November 11th, 1902, from 5.30 p.m. to 5.45 p.m., when the load on the sub-station was heavier. Fig. 12 shows the result of one quarter-hour from 5.30 to 5.45 p.m. In this case the down side has again less load than the up side. It will be seen that the batteries are also doing more work, at times taking peaks almost equivalent to half the total reducer load, and in the next few seconds charging almost to the same extent. The results of the three evening tests are tabulated in Table S II. (p. 114). The average transmission efficiency was 90·9%, the transmission and transformation efficiency was 86·2 per cent., and the transformation efficiency 95 per cent. Allowing for the batteries and boosters as before, the net sub-station efficiency was 81·8 per cent. Inspection of the voltage curves shows that the voltage regulation is all that could be desired, although the load sometimes rises to 700 amperes, while the maximum drain on the generating station for this peak was only 245 amperes.

The effect of running the sub-station without the batteries was then tried, and the result of two quarter-hour tests given in Table S III. (p. 114) and curves fig. 13. The shape of the curves is altered, the voltage regulation not being nearly so good as in the other cases, although it is still better than found on many lighting circuits. The motor and generator-armature current follow each other on the up side, although varying considerably, while the down-side record shows that a large amount of balancing is taking place. The extent

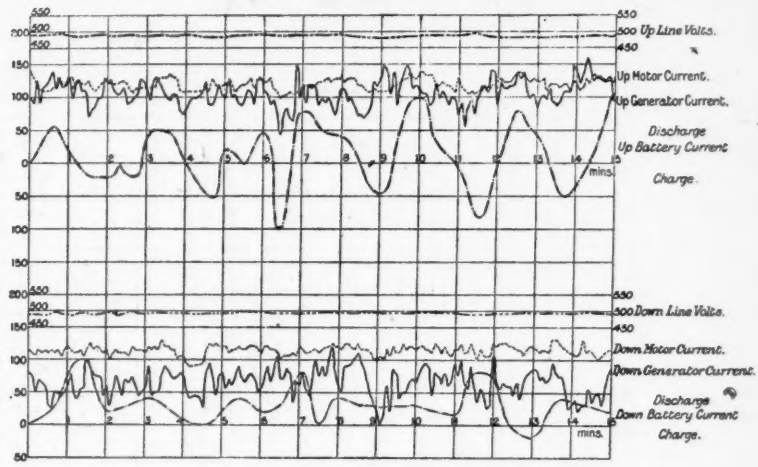


Fig. 12.—Angel Sub-station Tests.
Record taken November 11th, 1902, from 5 30 to 5.45 p.m.

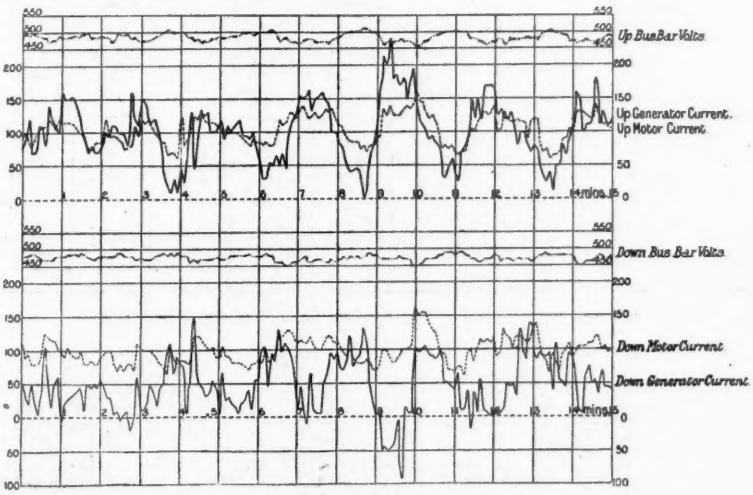


Fig. 13.—Angel Sub-station Tests.
Record taken December 15th, 1902, from 4.41 to 4 56 p.m.

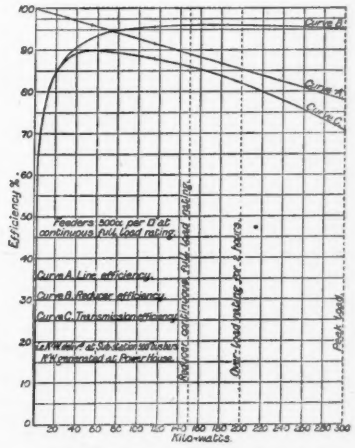


Fig. 14.—Angel Sub-station.
Calculation of Efficiency.

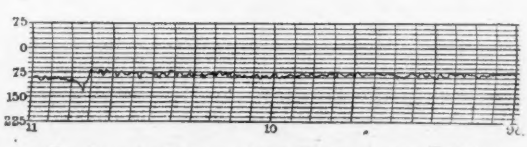


Fig. 15.—Amperes at 1,000 Volts, Angel Feeder.

Fig. 16.—Battery Amperes, Angel Sub station.

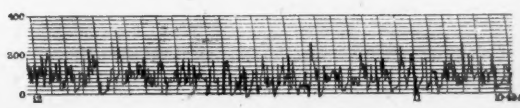


Fig. 17.—Amperes to Working Conductor, Angel Sub-station

of this balancing is clearly marked at one point where the up generator-armature current is 235 amperes, the motor current being 135, at the same instant the down motor current is 80 amperes and the generator current 50 amperes in the reverse direction; or, in other words, the generator-armature has become a motor-armature and pumps current from the down to the up side of the system. It will also be noticed that the amperes from the generating station on the up side vary from 60 to 160, while with the batteries this current is very nearly constant. Under these conditions the average efficiency of transmission was 91·1 per cent., the transmission and transformation efficiency being 83 per cent., and the transformation efficiency 91·1 per cent.; the low transformation efficiency being no doubt due to the amount of balancing taken up by the reducers.

It may be argued that a better net efficiency is obtained without the batteries, but it must be remembered that the sub-station is not at present fully loaded, and that by using the batteries the peaks at the generating station on the high-tension feeders are practically avoided. Further, the batteries are used in cases of emergency not only for the lift and lighting circuits, but also to feed the working conductor, and have a value in this direction which is rather hard to estimate. Fig. 14 gives the calculated efficiencies for this sub-station, and it will be noted that the values are somewhat higher than the actual efficiencies obtained in the tests.

The recorder charts in connection with this sub-station are also interesting. Fig. 15 shows the current in the down high-tension feeder. The current is practically constant at 80 amperes from 9 a.m. to 10.45 a.m., and then increases to 100 amperes, at which it remains fairly steady for five hours, during which the battery is being charged. Fig. 16 shows the current going into and leaving the battery. It will be noticed that at 10.45 a.m. the discharge, on the whole, is transferred to a charge on the whole, and this corresponds with the increased amperes in the high-tension feeder. Fig. 17 shows the amperes to the working conductor during the same period, where peaks of 400 amperes are reached, while the sub-station feeder current remains at 75 amperes on the down side of the system.

The difference between a battery working with a reversible booster, and one simply floating on the bus-bar, is shown by fig. 18, which is a chart from the battery at London Bridge sub-station working in connection with the reducers; the peaks seldom reach 80 amperes, and the average discharge is only about 30 amperes. From 11.35 a.m. to 1.25 p.m. the battery is being charged. A reference to the voltage chart, fig. 19, explains why the battery does so little without a reversible booster.

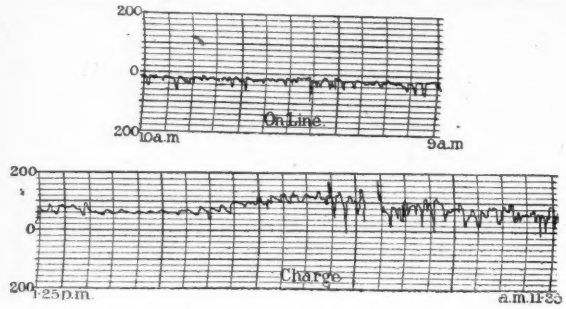


Fig. 18.—London Bridge Sub-station Amperes. Battery Floating.

Shortly after the opening of the Moorgate Street extension, it was necessary to run on the plain three-wire system; that is to say, the high-tension service was discontinued temporarily, and the high-tension feeders coupled direct to the low-tension bus-bars at the generating station. In this manner London Bridge sub-station was used as a battery station, and the performance of the battery under these conditions is shown on fig. 20. During ordinary working the battery took peaks of 175 to 200 amperes discharge, and charge to the extent of 50 to 60 amperes. The corresponding voltage chart is shown on fig. 21, and is very steady considering the conditions. From 6.15 to 7.5 a.m. the battery was off and the voltage drop was considerably more than with the battery; from 7.5 to 7.50 a.m. the battery was charging, and this gave a steadier voltage although lower than without the battery. At 8.45 a.m. when the load was

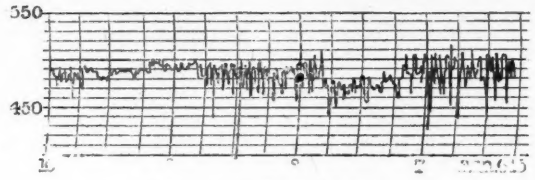


Fig. 21.—Up-Line Volts.

Table S. II.

Date. Nov. 11th, 1902. Time.		Generating station. Amperes.	Generating station. Volts.	Angel sub-station. Amperes. Motor armature.	Angel sub-station. Amperes. Generator armature.	Angel sub-station. Volts. High tension.	Angel sub-station. Volts. Bus-bar.	Kilowatts. To feeders at generating station.	Kilowatts. To reducers at sub-station.	Kilowatts. To sub-station bus-bars.	Efficiency. Transmission.	Efficiency. Transformation.	Efficiency. Transmission and transformation.	Remarks.
5.13 p.m.	Up ...	121·5	983	121·5	108	400	490	119·40	108·00	112·50				Average kw. put into battery = 29·25, of which 12% is lost = 3·51 kw.
to	Down ...	113·0	987	113·0	63	410	490	111·50	101·60	86·40				Average kw. wasted in Highfield booster = 6·86.
5.28 p.m.	Total ...	...	...	...	...	...	...	230·90	209·60	198·90	90·8%	95·0%	86·3%	Average kw. to line:—
5.30 p.m.	Up ...	120·7	983	120·7	108	400	490	118·70	107·40	112·00				= 199·68 − 10·37 = 189·31.
to	Down ...	113·0	987	113·0	64	400	490	111·50	101·60	86·75				Net efficiency:—
5.45 p.m.	Total ...	...	...	...	...	...	...	230·20	209·00	198·75	91·0%	95·2%	86·4%	$= \frac{189·31}{231·80} \times \frac{100}{1} = 81·8\%$.
5.50 p.m.	Up ...	125·0	985	125·0	112	400	490	123·00	111·20	116·00				
to	Down ...	113·0	987	113·0	61	410	490	111·40	101·70	85·40				
6.5 p.m.	Total ...	...	...	...	...	...	...	234·40	212·90	201·40	90·9%	94·8%	86·0%	
	Average...	...	...	...	...	...	...	231·80	...	199·68	90·9%	95·0%	86·2%	

Table S. III.

Date. Time.		Generating station. Amperes.	Generating station. Volts.	Angel sub-station. Motor armature.	Angel sub-station. Generator armature.	Angel sub-station. High tension.	Angel sub-station. Bus-bar.	Kilowatts. To feeders at generating stations.	Kilowatts. To reducers at sub-station.	Kilowatts. To sub-station bus-bars.	Efficiency. Transmission.	Efficiency. Transformation.	Efficiency. Transmission and transformation.
				Amperes.	Amperes.	Volts.	Volts.						
4.17 p.m.	Up ...	95	985	95	62	412	493	93·60	86·90	77·40			
to	Down ...	98	990	98	70	423	479	97·00	88·40	80·60			
4.32 p.m.	Total ...	...	...	...	...	...	...	190·60	175·30	158·00	92·0 %	90·2 %	83·0 %
4.41 p.m.	Up ...	104	985	104	102	405	482	102·40	92·30	99·35			
to	Down ...	99	990	99	47	421	473	98·00	88·50	69·10			
4.56 p.m.	Total ...	...	...	...	...	...	...	200·40	180·80	168·45	90·2 %	92·0 %	83·0 %
	Average ...	...	...	...	...	...	...	195·50	...	163·22	91·1 %	91·1 %	83·0 %

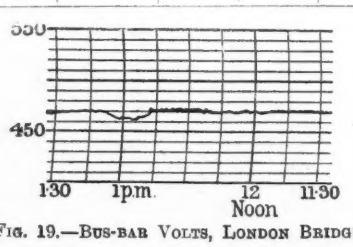


Fig. 19.—Bus-bar Volts, London Bridge.

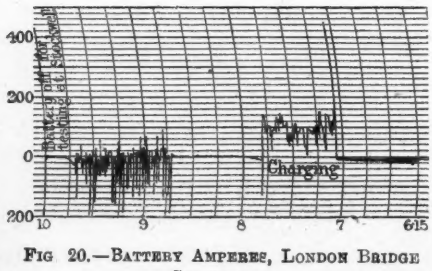
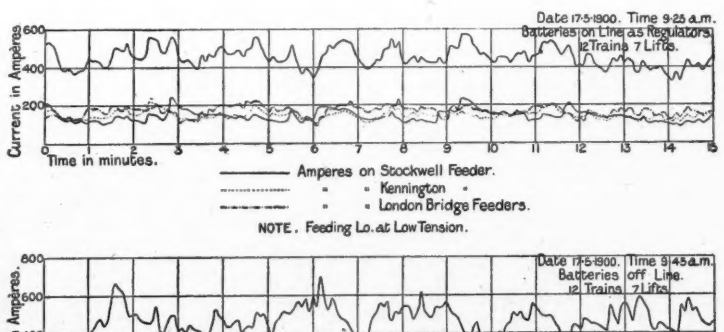


Fig. 20.—Battery Amperes, London Bridge Sub-station.



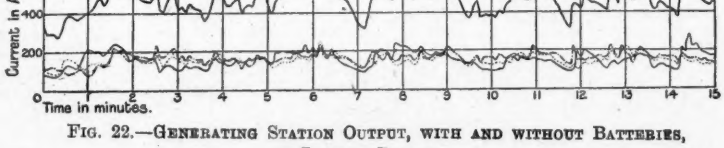


Fig. 22.—Generating Station Output, with and without Batteries, at London Bridge.

getting heavy, the battery discharged, and the result is at once noticeable on the voltage. In order to get some idea of the value of the battery as a means of steadying the load on the generating station, working under the conditions already described, five-seconds observations were taken at the generating station of the amperes going out in each feeder on one side of the system, with and without the batteries. Fig. 22 gives the result. With the batteries on

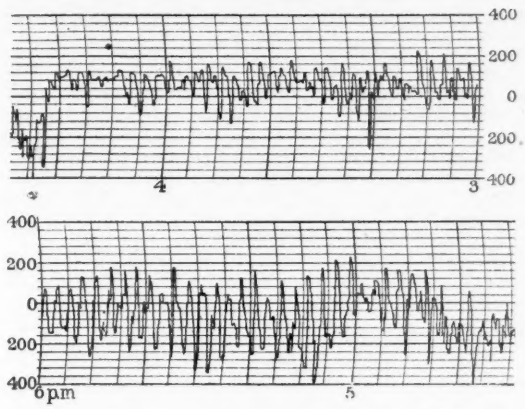


FIG. 23.—AMPERES, ANGEL SUB-STATION ALONE WORKING.

the line as regulators from 9.25 to 9.40 a.m., and without the batteries from 9.45 to 10 a.m., the number of trains and lifts running during the two tests were the same. Fig. 21 shows the result in voltage variation. Fig. 22 indicates that the battery steadies the load not only on the sub-station feeder, but on the Stockwell and Kennington feeders as well. The amount is not very great, but it is noticeable. As to the total value, with the battery the maximum peaks were 575 amperes once, and 560 amperes four times, and the minima were 330 amperes once, and 370 amperes four times; whilst, without the battery, the maxima were 700 once, 600 once, and 575, or a little over, eight times, whilst the minimum was 280 once and 320 several times. The maximum peaks were, therefore, about

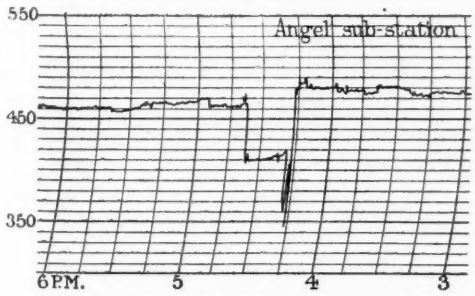


FIG. 24.—VOLTS, ANGEL SUB-STATION ALONE WORKING.

21 per cent. greater without the battery than with. The average amperes during the test were 471 without and 452 with the battery, or the average load on the generating station was about 4·2 per cent. lower with the battery. From the general shape of the peaks during the two tests, it would appear that to run without the battery would require generators with an output of about 10 per cent. greater than with the battery.

As already referred to, a large battery has a value as a reserve which is rather hard to estimate, and this is clearly shown by figs. 23 and 24 giving the recorder charts for the Angel sub-station on one occasion when London Bridge sub-station was thrown out of use by a short-circuit on the back of one of the switchboard panels. Fig. 23 shows the battery amperes before and after London Bridge sub-station was shut down. After the "short" the Angel sub-station took the whole load and the battery gave discharge peaks up to 400 amperes, also charging up to 200 amperes, the pressure at the extreme end of the line being only reduced by 20 volts, and at London Bridge the working conductor voltage was practically unaltered, or at least the drop in no way interfered with the working of the traffic or caused inconvenience in the matter of train lighting.

BALANCING AND RAIL DROP.

Mention has already been made of the useful effects of the reducers at the sub-station acting as balancers, and, in addition, the balancer at Moorgate Street station takes up most of the out-of-balance load as shown by the curve, fig. 25.

With such good balancing the rail drop is naturally small, and it would appear that the three-wire system as installed on the City and South London Railway has not yet reached its limits in regard either to the distribution or to the Board of Trade rail drop. An inspection of the recorder charts taken at three points along the line shows that the rail drop does not increase with the distance from the generating station. In fact, it is very little greater at the Angel than it is at London Bridge or at Moorgate Street stations. Fig. 38 shows the drop between the generating station and London Bridge.

About one-half of the total energy generated is delivered to the line at 500 volts, or direct without any transformation, the efficiency of the various points along the line being as follows:—

Stockwell	99·3 per cent.
Kennington	96·6 "
London Bridge	86·0 "
Angel	81·6 "

The average efficiency over the whole system is 90·9, or, say, 91 per cent. From this must be deducted the loss in the working conductor before the net efficiency of distribution to the locomotives can be obtained. Taking the average current density in the working conductor with the average train service, the maximum loss between the feeding points farthest apart is just over 1 per cent., and with the feeding points closer, the loss is just under 1 per cent., so that the average loss between the end of the feeders and the locomotives is well covered by 1 per cent. The net efficiency of transmission from the switchboard in the generating station to the locomotives is thus 90 per cent.

The cost per unit for the half year ending June, 1902, is given below. The figures refer only to the works cost. To compare the results with a lighting station, the cost of management, directors, office and legal expenses, insurance, &c., should be added; but as the above items are divided over all departments of the railway, and it is purely a matter of opinion what percentage should be charged to generating only, the item can be omitted without materially affecting the results, and a comparison made on the basis of works costs only. The units generated were 3,781,087. The coal per unit generated over the half year, including all standing-by losses, lighting up, fresh boilers, &c., was 3·9 lbs. of north-country and midland small coal. During a month of this period, when coal of a slightly higher calorific value was used, the coal per unit was 3·28 lbs., including all losses as before.

Cost per unit generated, in pence.

Coal	0·310
Water, oil waste, and other stores	0·046
Wages, including engineer in charge ...	0·056
Repairs and maintenance	0·028
Total works costs	0·440
Sub-station charges, including those of battery maintenance, &c.	0·035
Load factor	49·2 per cent.

For the same period the ton-miles were 27,832,000, and if the units per ton-mile on board the locomotive are taken, namely, ·0552, the coal per ton-mile was 0·215 lb. or 3·45 ounces.

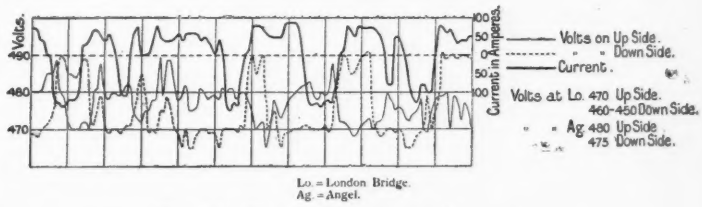


FIG. 25.—BALANCER VOLTS AND AMPERES.

In order to place the results on a basis for comparison with steam locomotives, the coal per ton-mile at the switchboard should be taken, and this amounted to 0·237 lb. This figure includes all boiler house losses, such as lighting up boilers and banking fires, &c. If compared with main-line locomotives the result is in favour of the latter, but it must be remembered that the energy spent upon accelerating main-line trains is only a fraction of that spent on a line with short sections, and, as has already been shown by the author in his paper * on "Tractive Resistance in Tunnels," the tractive resistance per ton is at least double that obtained in main-line practice. The published results obtained with steam locomotives are usually taken over short periods, and refer to special tests from which all standing-by losses are excluded. When the time arrives at which electric locomotives can be tried under conditions similar to those of steam locomotives, there is every reason to believe that the coal per ton-mile will be in favour of the electric locomotive.

While on the question of locomotives, it may be interesting to give some details of their upkeep. With the old type of locomotive with Gramme surface-wound armatures, the chief source of trouble was the failure of the armature winding due to its shifting on the core, thereby causing short-circuiting and burning-out. The field magnet winding seldom or never gave any trouble, due no doubt to the liberal allowance of copper, and to the bobbins being on the earth side, and therefore subjected only to a pressure equivalent to the drop of volts across the winding. Taking the history of 30 of these armatures in every day use, after running 100 000 miles the winding began to show signs of failure, at between 100,000 and 120,000 miles the failure became more frequent, and when an armature ran 150,000 miles it was generally necessary to re-wind it, the cost being about £20. 180,000 miles seems to have been the best record with a single winding failure, and several cases of 175,000 have been recorded, the average being 100,000 miles. Cases have arisen where failures took place after 1,000 miles or less, but as a rule some external cause was discovered. To obtain the above results the locomotives were only allowed to run about one

month, when the armatures were taken out and cleaned, thoroughly varnished with shellac, and baked in an oven; if this precaution was neglected, trouble always resulted.

The later and more powerful locomotives which were described in the author's paper on "Electric Locomotives"* have not been in use long enough to institute a comparison on exactly similar lines, but the records so far, show that the slot-wound armature is vastly more satisfactory than the smooth-core armature. Some of these locomotives ran 13 months continuously without coming into the repair shops for overhauling, the mileage being 46,000. The highest mileage yet recorded is 110,000 continuous running, the average being about 75,000 miles; and from our experience there appears to be no reason why, these figures should not reach three or four times their present magnitude before winding troubles arise. In the 32 locomotives of this class, of course, armature failures have occurred, some due to external causes, and others to defective insulation; but 50 armatures out of the above locomotives have run an aggregate of 3,245,900 miles without a single winding failure. This is a very satisfactory record, and if the general result of the trustworthiness of the locomotives is expressed as a percentage of the time lost through armature failures, it comes out at 0·16 per cent. Or, for the past six months, of the total running time, only 0·16 per cent. was lost.

The maintenance and running costs are also low, as shown by the following figures:—

Oil, waste, and other stores used on locomotives	0·098d. per train-mile.
Repairs, materials used on locomotives	0·137d. " "
Wages spent on repairs...	0·230d. " "
Total cost per train-mile, including all salaries and wages connected with the generation of power, running of locomotives, coal, water, and other stores, material, and wages for repairs ...	4·61d.

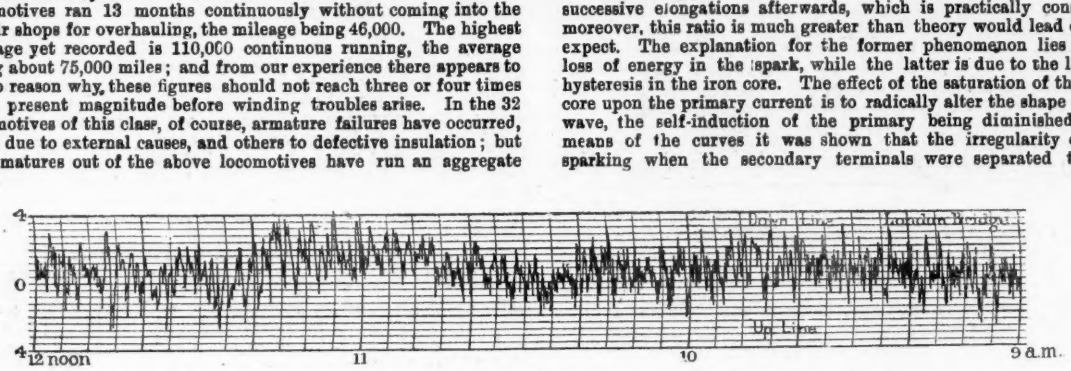
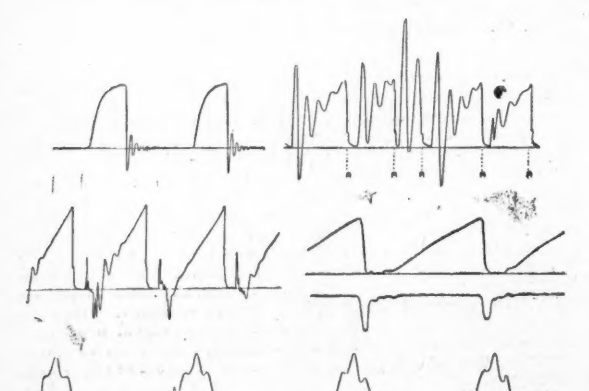


Fig. 38.—Rail Voltage Drop between Generating Station and London Bridge.

ON THE FORM OF THE CURRENTS IN INDUCTION COILS.

An interesting series of experiments has been made by M. H. Armagnat with the Blondel oscillograph, the results of which were published in *L'Eclairage Electrique*, of November 14th last. Experiments were made to determine the form of the primary current wave, the P.D. between the terminals of the primary coil, and the rate of change of the magnetic flux by means of a small search coil wound on the iron core. The records were received on a photographic plate, the duration of the oscillations at the moment of rupture being exceedingly brief.



Figs. 1, 3, 5. Figs 2, 4, 6.

The primary current followed the form indicated in fig. 1, the coil being of 35 cm. spark, and the interrupter being of the mercury type. The resistance in circuit was 8 ohms, allowing a maximum current of 15 amperes to pass at 120 volts, and the capacity shunted across the break was 6 mfd. The figure shows that the ratio of the first elongation to the s cond is far greater than the ratio of successive elongations afterwards, which is practically constant; moreover, this ratio is much greater than theory would lead one to expect. The explanation for the former phenomenon lies in the loss of energy in the spark, while the latter is due to the loss by hysteresis in the iron core. The effect of the saturation of the iron core upon the primary current is to radically alter the shape of the wave, the self-induction of the primary being diminished. By means of the curves it was shown that the irregularity of the sparking when the secondary terminals were separated to the utmost was due to the defective action of the interrupter. By adding capacity to the terminals of the secondary coil, oscillations of extremely short period were produced, which had no apparent connection with the calculated frequency of either the primary or the secondary coil; three independent sets of vibrations were detected, of widely different characteristics. When the secondary circuit has low resistance or large capacity, the reaction of the secondary oscillations is so great as to cause violent oscillations in the primary current, as shown in fig. 2, where the rather irregular interruptions are indicated by the letter R. The effect of "false contacts" at the interrupter is illustrated by fig. 3, under similar conditions. The same coil, without capacity at the terminals, gave fig. 4, the diminished reaction being clearly evident, as the primary current fell to zero quickly and almost without oscillations, the energy being absorbed by the secondary spark of 20 cm. The curve of dx/dt given below the primary current curve shows the form of the E.M.F. wave in the secondary. On reducing the length of the spark to 2 cm., the secondary current so much retards the demagnetisation of the core, that the interrupter armature is held back and the interval between breaks largely increased. Experiments made on a very large coil for radiography, with a closed iron circuit and a primary coil excited by an alternating current, produced some curious results. Fig. 5 shows the violent reaction of the secondary current on the primary at the moment of the passing of the spark in the spark-gap, and the presence of the 25th harmonic in the primary current is clearly shown. The latter is due to the resonance of the secondary circuit, containing two condensers and the spark-gap, and furnishes a means of estimating the capacity of the latter circuit. When the gap was short-circuited, bringing the capacity of the condensers into play, the 11th harmonic was resonated, as in fig. 6. Other experiments related to the action of the Wehnelt interrupter, and showed that the current never falls to zero, while the rate of make is nearly as great as that of break, so that two sparks can be obtained per interruption. Many singular points in addition to the above are brought out in the original article.

* *Journal I.E.E.*, 1899, Vol. 28, p. 508.

SOME ELECTRICAL EXHIBITS AT THE FRENCH AUTOMOBILE EXHIBITION.

[by our special representative.]

Only those who visited the Automobile Exhibition held in the Grand Palais, Paris, from the 10th to the 25th ult., have any idea of the feverish activity at present reigning in the automobile industry. The *Salon*, as it is termed, was by far the largest so far held, and when we say that there were over 800 exhibitors, but a faint notion is conveyed of the vastness and importance of the Exhibition, which was attended by automobile traders and motorists from practically every civilised country. In fact, the annual show organised by the French Automobile Club has come to be recognised as the automobile market of the world, and from present indications, it is likely to hold this enviable position for many years to come. Petrol as a motive power stands like a giant above all other forms, there being but two exhibits of steam cars, while those of electrical vehicles could be counted on the hands. But if petrol cars are thus in the great majority, their popularity has given rise to an important business in the thousands and thousands of sparking plugs, induction coils, contact makers and interrupters, accumulators, and many other accessories required in connection with the ignition of the explosive charge in the combustion chambers of the engines, which is now entirely performed electrically, either by means of the batteries and coils already mentioned, or by magneto machines. Needless to say, there was a large number of exhibitors of accumulators and dry batteries for ignition purposes, and although secondary batteries are still mainly employed for this purpose, there seems a slight tendency towards the primary battery. The

supremacy of both is, however, being attacked by magneto ignition. Probably the most interesting exhibit in the accumulator section was the alkaline battery shown by Mr. Jungner, of Norrkoping, Sweden, for which priority over the Edison battery is claimed. [See ELEC. REV., January 30th, 1903. "Edison *contra* Jungner," by W. Hibbert.] In the Jungner accumulator, electrically-produced nickel electrodes are used for the positive, and iron or cadmium for the negatives. The capacity of the accumulator is 60 ampere-hours, at a discharge rate of 5 amperes, or 40 ampere-hours at 20 amperes. The useful effect per kilogramme of total weight is given as 24 watt-hours at slow discharge rates, or about 20 watt-hours with rapid discharge. An important claim made for the new accumulator is the long life of the electrodes, as compared with those of the lead or pasted type; one has, we understand, been charged and discharged no less than 500 times without showing any reduction in capacity.

Among the magneto machines, mention may be made of the new Simms-Bosch, the Eisemann, the Comete, the Delta, the Compound and the "P M." The Eisemann magneto, which works in conjunction with an induction coil and the usual form of sparking plug, has been adopted for the petrol cars of Messrs. Panhard & Levassor. Of sparking plugs, induction coils, and contact makers, there was also a large display, some very ingenious devices being comprised in the last-named commodities. As regards the induction coils, too, a good deal of progress has been made with the production of instruments, the tremblers of which are adapted to work at a very high speed.

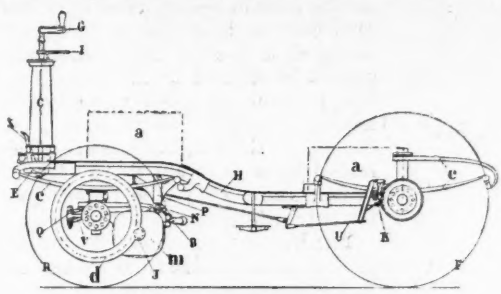


FIG. 1.—ELEVATION OF KRIEGER ELECTRIC CAR

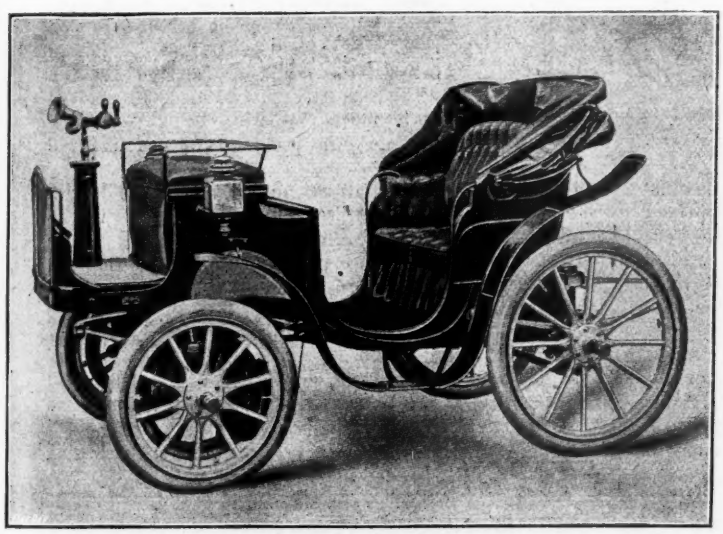


FIG. 2.—THE KRIEGER ELECTRICAL VICTORIA.

Although a number of firms exhibited electrical vehicles, nothing very startlingly new was observable. Perhaps the most noteworthy feature in this respect was the appearance, for the first time in this branch, of an English firm—the Electromobile Co., Ltd., of Curzon Street, W.—whose exhibit came in for a large amount of attention. A victoria, a landaulet and a *coupé* were on view, as well as a *chassis*, which in automobile parlance is taken to mean the frame and entire mechanism—in fact, everything except the carriage body. The feature of the Electromobile vehicles is their relatively low build, this being obtained by the employment of a straight steel frame. The motor, which is of the Contal-Gasnier enclosed type, is of 8 H.P., and is spring-suspended at the rear, driving on to the rear live axle through spur gearing. The battery consists of 44 cells slung below the centre of the frame; its capacity is stated to be sufficient for a run of about 38 miles on one charge, at speeds ranging up to 12 miles an hour. An ingenious form of controller is employed, this being actuated from the inclined steering column, and adapted to give 10 different positions, viz., start, stop, five forward speeds, the reverse motion, and two electric brakes.

Among the best known types of electric cars in Paris are those of the Compagnie Parisienne des Voitures Electriques (Procédés Krieger). As is already fairly well known, the principal feature of this system is the employment of two electric motors connected one to each of the front road wheels, which are thus used both for driving and steering. Fig. 1 represents in outline an elevation of the general arrangement adopted in these vehicles. The front axle has the form of a fixed cross-bar. At the end of the bar is a pivot which turns a short axle carrying the road wheel. The electric motors, *m*, are fixed to a support on the cross-bar, and close to each of the front wheels. The motors drive the wheel by small pinions, *j*, which engage with large fibre gear wheels, *d*, fixed to the road wheels. In this way each wheel is driven by its own motor, and electrically forms an independent system. One wheel may thus turn faster than the other, the use of a differential gear and its consequent mechanism being in this way obviated. The motors are of the four-pole type; on one end of the outer casing of the same is cast a ring-shaped projection, which fits upon a collar on the journal. The motor is thus supported, and at the same time can take a certain angular displacement, which is, however, limited by a curved spring which holds up the free end of the motor (see fig. 3). This method of supporting the motors greatly reduces the strain on the same, when starting or stopping the vehicle. The motors, which are interchangeable and readily detachable, are entirely enclosed, so that no dust or dirt can get into the working parts. The battery of accumulators is divided into two groups, *a*, *a* (fig. 1), its capacity on one charge ranging from 40 to 50 miles, at an average speed of about 12 miles per hour. It consists of 44 cells, one half being located under the driver's seat, and the other half under the rear seat. In the latest Krieger cars a battery known as the Phénix is being used. In this the electrodes do not consist of plates, but of vertical rods, the positive one being enclosed in porous pots. The arrangement is claimed to prevent disintegration of the active material, which remains firmly connected with the contacts, notwithstanding any jolting or vibration caused by bad roads. Among other claims made for the Phénix accumulator are lightness, large surface, and a high ratio between the weight of the active material and that of the supports. They are also said to require much less attention in the way of cleaning out than the usual plate type. The 125-ampere hour cell comprises 42 electrodes, and weighs 23½ lbs. The controller, 1 (fig. 1), which is mounted on the steering standard, is adapted to take 11 different positions, viz.: stop, start, five speeds forward, reverse motion, electrical brake, and battery recuperation (two). All parts of the controller switch can be readily inspected and cleaned, it being enclosed in a detachable cylindrical envelope. In addition to the electrical brake, band brakes controlled by a pedal, on the rear wheel hubs, are provided. The frame of the vehicles is built up of wood and steel, and is spring-suspended on the axles. The wooden road wheels are shod with pneumatic or solid rubber tires, as desired. The cars are fitted with electric side and internal lights, while a useful departure is the fitting of a small electric lamp, just above the volt and amperemeters, on the dashboard, to enable the driver to see these clearly at night.

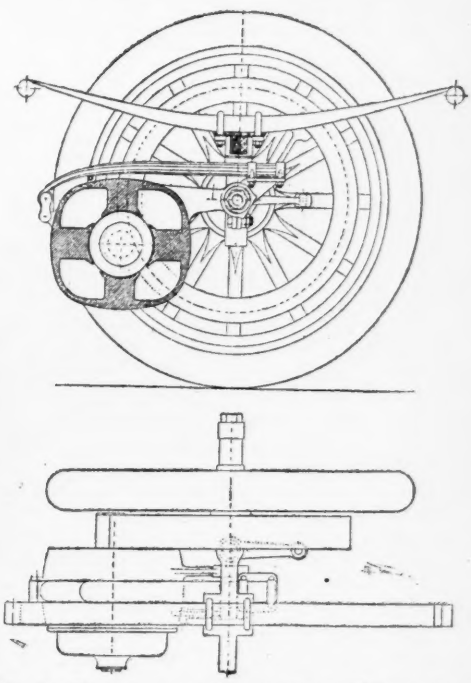


FIG. 3.—ELEVATION AND PLAN SHOWING METHOD OF SUPPORTING MOTOR IN KRIEGER CARS.

Other exhibitors of electrical vehicles included La Société l'Electrique, Paris, whose "Gallia" vehicles are provided with two motors, each driving a rear road wheel through helical gear wheels; M. Jeantaud, Paris, who is bringing out a new accumulator for traction purposes, claimed to have double the capacity for a given weight of the ordinary type, but of which no definite particulars are so far available; La Société Electromotion, and M. C. Mildé. Of the latter's vehicle we hope to give some particulars in an early issue.

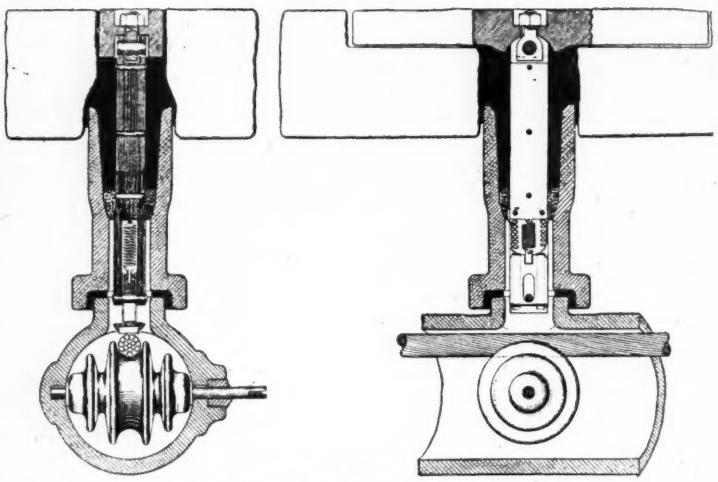
(To be concluded.)

THE "G.B." SURFACE-CONTACT SYSTEM.

Tramway engineers and municipal authorities, whose ultra-æsthetic temperaments have been outraged by the erection of overhead trolley wires, and perhaps by "cobweb corners," as we have heard some crossings described, will probably welcome the introduction to their notice of another surface-contact system.

From force of habit, engineers are apt to regard any kind of surface-contact system from a sceptical standpoint—probably the outcome of the many attempts and failures which are associated with the past history of this description of electrical tramway work.

However, our visit to the trial track of the G.B. Surface-Contact Co., at Ilford, on the 6th inst., proved, in several particulars, somewhat of a surprise, and although the difficulties associated with the operation of regular tramway working in a town can be only approximately gauged from trial runs on a small circular track, yet the promoters claim to have made an important advance on previous surface-contact systems, as will be gathered from the following description.



Sectional Views of Stud and Contact Maker.

The system consists primarily of a number of fixed contact studs placed at intervals of 7 ft. 6 in. down the centre of the track, and level with the paving; a bare power cable, running on insulators, inside a conduit laid under the centre of the track, connection between which and the studs is effected magnetically, at the moment the car magnet comes over a stud, and ceases on its leaving the latter. A special form of flexible collector is used in conjunction with the magnet, the collector being attracted on to the studs only when immediately over them, and normally travelling at a height of about $\frac{5}{8}$ in. above the road surface.

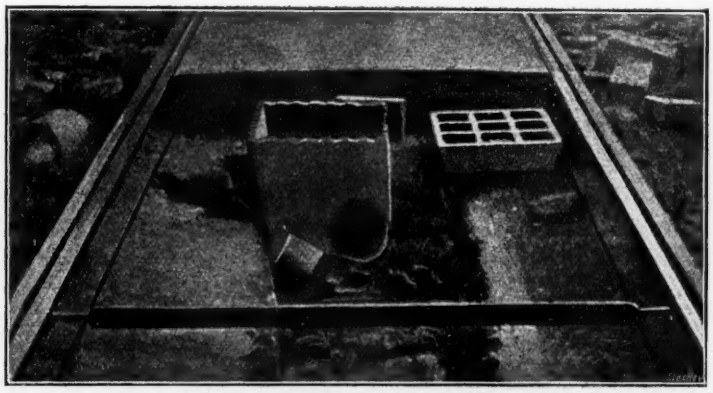
The conduit in which the cable is carried consists of ordinary 5-in. glazed stoneware pipes, which are embedded in concrete. The necessary excavation does not exceed 19 in., and this could be decreased if necessary. The small junction pieces, which receive the shanks of the studs, are also of earthenware. The insulators are made of insulator clay, thoroughly glazed, they are mounted loosely on galvanised steel pins, which project through one side of the conduit, the projecting ends being connected together by means of a galvanised iron strip which is connected at intervals to the rails.

This arrangement is claimed to prevent absolutely the possibility of a stud becoming alive, in consequence of leakage over the insulating surface, separating the power cable and the stud. The power cable is a galvanised iron stranded one, with a hempen core, giving about the same current-carrying capacity as a trolley wire, but capable, by inserting a copper core, of greatly increasing this amount, and, if necessary, displacing feeder cables. Cast-iron access boxes are placed at 200 to 400 yds. interval. They are provided with manganese steel covers, paved with granite or wood, and suitably drained when necessary. The contact studs have cast-iron heads, 14 × $2\frac{1}{2}$ wide on the straight, and 5 in. wide on curves, which do not project above the road level, and are renewable for 15d. The studs are let into granite blocks and run with bitumen; and will wear uniformly with the rest of the road bed between the rails.

The shank or downward projection of the stud is of laminated iron strips riveted together and forked at the lower end; the inner surfaces of the jaw being lined with brass. Within the jaw is mounted the only moving piece in connection with the track equipment, a small contact maker, consisting of a piece of iron with a carbon contact block fixed to the bottom edge. This is freely suspended by means of an insulated phosphor bronze spring, from the top of the jaw, its movement being limited by a brass pin, which is riveted to each side of the jaw, and which passes through a slot in the contact maker.

Flexible copper leads connect the latter to the shank of the stud. When a car magnet passes over a stud the moving contact maker is magnetically attracted on to the cable, against the pull of the spring (which equals some 16 ozs. when contact is made), and when the car has passed, is drawn up by the spring. The joint between the shank of the stud and the vertical branch pipe is made by running in bitumen, the latter being supported on jute yarn packing wound round the shank.

The car used at the trials was an ordinary double-decker, 10 tons in weight, capable of seating 54 passengers. It was fitted with two 25-H.P. Walker motors, and Dick, Kerr controllers. Two collectors are provided, one under either end of the truck. The collectors consist of link chains, fixed to the lower ends of iron tongues, which in turn are spring suspended within two parallel iron bars forming one pole of the magnet, their motion being limited by steel pins passing through slots. The magnets, consisting of three horizontal electro-magnets fixed to each end of the car, are excited from a battery which is arranged for charging on occasions from the motor current, and so avoiding special charging arrangements. The exciting energy, measured during the trial, amounted to 30 amperes at 10·8 volts, or some ·04 watt per car-mile.



Inspection and Disconnecting Box

The track over which the trial runs took place, was a circular one about $\frac{1}{4}$ mile in length, and 4 ft. $8\frac{1}{2}$ in. gauge. The sharpest curve had a 54 ft. radius, and the steepest gradient was 1 in 32. It was partly laid with granite, wood-

paving, and gravel, and was in the condition, in which the recent floods, extending over several weeks, had left it.

The car running light round the track took 21 to 35 amperes, at 500 volts; track leakage tests disclosed a momentary leakage of ·5 ampere; when a bucket of water was thrown over a stud, this amount gradually dropped to ·05 ampere, which would represent the leakage during very wet weather; the normal dry weather leakage was ·025 ampere.

Tested for track leakage, with the collectors on the studs, a leakage of ·2 ampere was registered, and we gathered that 2 to 3 amperes leakage, would take place with a salted track. The car was run with the brakes on, and the readings showed that the contacts were passing 95 amperes. In order to demonstrate the fact that the circuit is not broken inside the conduit, a contact beneath the track was left visible from above, and on a car passing over, it was observable that the contact maker was not drawn up from the cable until an appreciable interval, after the collector had left the stud.

The slight sparking visible when the contact lifted was due to leakage current only.

It will be noted that the magnet pole over the collector has extensions at either end, and these tend to prolong the magnetic action after the collecting chain has passed the stud.

As a safeguard against studs being left alive after a car has passed, a short-circuiting device carried by the car will, on passing over a live stud, cause an automatic cut-out to open the motor circuit and bring the car to a standstill.

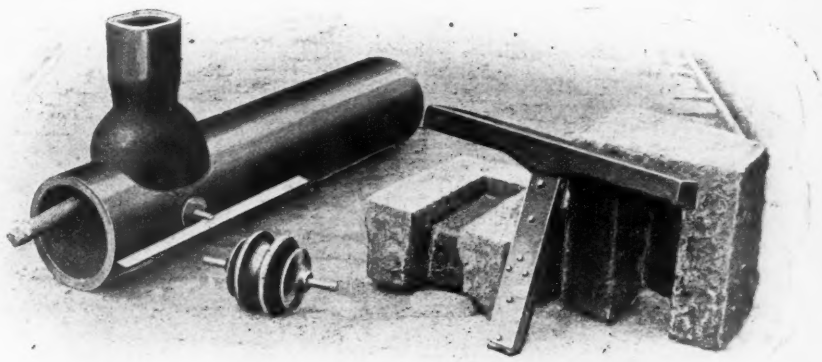
The faulty stud when found can be removed by using a special blow lamp to warm it up, and then prising it out with a crowbar, a matter of 10 minutes.

From the above it will be seen that the G.B. system is claimed to possess several virtues not present in some other surface-contact systems.

The foremost is probably the simplicity of the "out of sight" equipment; another, the possibilities of cheap construction, which will appeal to the pocket; and a third, which will influence road authorities, is the fact that the track paving and stud heads form a perfectly level and rigid surface at all times.

Tramway engineers will probably be somewhat suspicious of the spring-controlled contact maker; they might justifiably suppose it would get choked up if muddy water found its way into the conduit, even allowing that the springs are perfectly reliable; against this, however, may be placed the inventor's claim to 18 months' satisfactory experience, during which he has run several tens of thousands of car-miles over the trial track, the latter (and the conduit) during that time being flooded for several weeks, and not cleaned out when we inspected it.

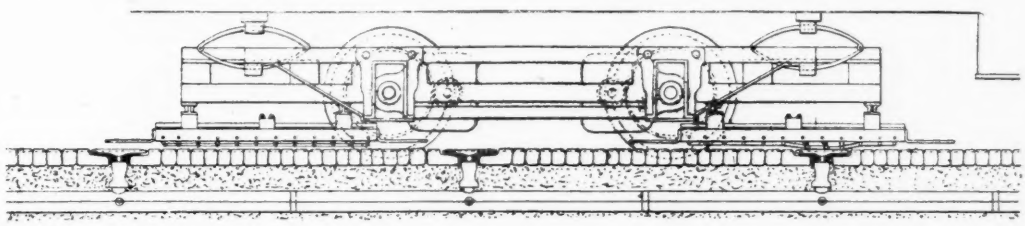
The trial demonstrated the ability of the collector to make efficient contact through thick mud, and no doubt the G.B. motor-man will learn to regard dry newspapers lying in the centre of the track in much the same light as the trolley motor-man regards a sectional insulator. There are undoubted difficulties ahead at complicated crossings, which it will be necessary to "coast" over, as in the case of conduit tramways; but here, again, what is good enough for London tramway crossings will probably be good enough for provincial towns.



View of Contact Stud and Accessories.

As to how far these several points will influence the prospects of the G.B. system under traffic conditions, time only can decide; but it is to be hoped that the ingenuity which has overcome the difficulties up to the present will be equal to the obstacles of the future.

We understand that Folkestone is likely to be the first town to adopt the system.



Current Collectors Under Car.

In conclusion, we must express our appreciation of the many facilities afforded to us for inspecting the system.

ELECTRIC OVERHEAD TRAVELLERS IN CENTRAL STATIONS.

By E. KILBURN SCOTT, M.I.E.E., A.M.I.C.E.

The majority of electric light stations are equipped with overhead travellers worked by hand, and yet considering that the power costs them next to nothing, one would expect electrically-driven travellers to be the rule rather than the exception. In this matter, as in so many others connected with electrical work, fashion has a good deal to answer for—the template pattern idea is difficult to "scotch."

The writer's objection to the hand traveller is that it is so terribly slow in cases of emergency and monopolises hands which could be put to more important work elsewhere. Then again, the cotton hand ropes have a most tantalising way of twisting round and round each other after they have been slightly stretched. They also hang down nearly to the floor, and are apt to catch in some of the fittings; more than one accident is traceable to this cause.

The principal objection to electrically-driven travellers, particularly of the three-motor type, is that of price; yet the writer knows of a contracting firm who installed a three-motor crane, although they were only asked to supply, and were only paid for a

hand crane. They explained that they made much more than the difference in price by the saving in time in erecting the machinery, &c. As a matter of fact, they had the crane in position before the roof was finished, and used it not only for erecting the engines and dynamos, condensers and pipework, but also for the engine foundations, floorings, switchboard platform and general interior fittings of the building.

In this connection it is interesting to note distinct evidence of the drawing together of certain well-known crane-makers and electrical firms, and the consequent standardisation of patterns has resulted in a most reliable article at a very reasonable price; indeed, in many cases at lower prices than the same crane can be bought for on the Continent.

One other point is the question of example. Every central station engineer longs for a motor load; would it not, therefore, be well for him to have motors sprinkled all over his station, so that local contractors could bring in wobbling customers and visually convince them of the advantages of motor driving? The engine room staff might even be trained into doing monkey tricks with the electric traveller, such as whipping a spare armature from one end of the station to the other and suddenly dropping it within an eighth of an inch of the said wobbling customer's hat. Much in the same way, for example, as a steam hammerman cracks nuts for Royalty when they visit a steel works.

Joking apart, however, there is much to be said for the electric traveller, and if this article shames some of our central station engineers into giving orders for new cranes or equipments, the writer will be well pleased.

NEW PATENTS APPLIED FOR, 1903.

Compiled expressly for this journal by W. P. THOMPSON & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, to whom all inquiries should be addressed.

27,969. "An automatic pump for regulating the water in the pump or well beneath the transformation chamber in underground electric supply works." H. DE GARBS. December 21st.

28,003. "Telephone transmitter." W. FAIRWEATHER. (The Kellogg Switchboard and Supply Co., United States.) December 21st. (Complete.)

28,057. "Composition for use in the cells of electrical batteries." W. H. WHEATLEY. (The Atwood Electric Co., United States.) December 21st. (Complete.)

28,051. "Improvements in synchronising apparatus for electrical machines." P. M. LINCOLN. (Date applied for under Patents Act, 1901, December 29th, 1902, being date of application in United States.) December 21st. (Complete.)

28,060. "Improvements in compensating systems for alternating electric current generators." E. E. F. CREIGHTON. (Date applied for under Patents Act, 1901, December 20th, 1902, being date of application in United States.) December 21st. (Complete.)

28,071. "Guide to facilitate the attachment of trolley head to trolley wire." W. H. MACKENZIE. December 22nd.

28,073. "Improvements in electrical light fittings." VERITYS, LTD., and P. G. EBBUTT. December 22nd.

28,076. "Electrical milk separator and preservative." C. LILLICRAP. December 22nd.

28,079. "An electric chemico process of printing books, newspaper posters and type-written sheets." A. W. TURNER. December 22nd.

28,093. "An improved universal turn, steam, hydraulic, electric or hand crane." J. VAUGHAN. December 22nd.

28,147. "Improvements in electrically-operated switches." W. H. HILLYER. December 22nd. (Complete.)

28,177. "Improvements in or relating to pocket electric lamps or lighting appliances." W. QUASCHNING. December 22nd.

28,183. "Improvements in and relating to electrically-actuated musical instruments." W. K. L. DICKSON. December 22nd.

28,215. "Improvements in electrical resistance cells." VERITYS, LTD., and G. O. DONOVAN. December 23rd.

28,241. "Window cleaner driven by an electro-motor." J. F. HOYNE. December 23rd.

28,252. "An improved electric lighting batten for theatrical and other purposes and method of preventing confusion of colours by lamps therein." L. SUNDERLAND. December 23rd.

28,268. "Improved construction or formation of galvanic elements for medico-electric generating appliances or apparatus." F. DERBY. December 23rd.

28,282. "Improvements in coin-freed apparatus for electric light supply." A. SABAT. December 23rd. (Complete.)

28,290. "Improvements in wave telegraphy." R. A. FESSENDEN. December 23rd. (Complete.)

28,291. "Improvements in receivers for electro-magnetic waves." R. A. FESSENDEN. (Date applied for under Patents Act, 1901, April 9th, 1903, being date of application in United States.) December 23rd. (Complete.)

28,324. "An automatic weigher for grain, coal or other flowing materials, electrically controlled." C. J. SIMEON, T. ST. J. B. PARNALL and W. E. HIPKINS. December 24th.

28,334. "Improvements in connection with the trolleys of overhead electrically-driven vehicles." H. H. WILSON. December 24th.

28,355. "Trolley-catchers." C. B. ROBERTSON. December 24th. (Complete.)

28,400. "Improved process for the production of hydroxides and oxides of metals by electrolysis." F. F. HUNT. December 24th. (Complete.)

28,401. "Improvements in and relating to electric arc lamps." C. PERDRISAT. December 24th.

28,417. "Improvements in and relating to electric vapour lamps." E. WEINTRAUB. (Date applied for under Patents Act, 1901, December 26th, 1902, being date of application in United States.) December 28th. (Complete.)

28,422. "The supreme electric door-handle alarm." S. W. QUICK. December 28th.

28,445. "Improvements in connection with the trolley pulleys of overhead electric tramway systems." F. BARRITT and W. A. FRASER. December 28th.

28,453. "An improved electrical motor-starting switch." J. CROWTHER and U. HORSFALL. December 28th.

28,503. "Improvements in the electrolytic extraction of zinc, from its ores and apparatus therefor." A. G. BLOXAM. (Société Anonyme d'Etudes Chimiques, Switzerland.) December 28th.

28,514. "Improved electric stand lamp." G. KAMM. December 28th.

28,545. "Improved machine for covering wire with insulating material." W. G. HEYS. (W. E. Ammon, United States.) December 29th. (Complete.)

28,553. "Improvements in the construction of electric arc lamps. A. ECKSTEIN and A. E. ANGOLD. December 29th.

28,557. "A new improved electrical terminal connection protector for sparking plugs for motors and all electrical appliances." E. M. GOLDBURGH. December 29th.

28,568. "Improvements in and connected with section insulators for electric tramways." J. MONEY. December 29th.

28,574. "A combined electric switch and fuse." H. S. SOUTTAR and T. HAMILTON-ADAMS. December 29th.

28,580. "Improvements in or connected with transformers employed in high frequency current circuits." G. E. GAIFFE. December 29th.

28,607. "Improvements in or relating to electrical fuse-holders, fuse-boxes and the like." F. G. BAILY. December 29th.

28,623. "An improved joint box for electrical conductors." H. S. MARTIN. December 30th.

28,632. "Improvements in metallic conduits for electric light cables and the like." L. M. WATERHOUSE and THE SIMPLEX STEEL CONDUIT CO., LTD. December 30th.

28,662. "Improvements in electric chain-welding machines." H. HELBERGER. December 30th. (Complete.)

28,699. "Improvements in telegraphy." H. O. RUGH. December 30th. (Complete.)

28,700. "Improvements in telegraphy." H. O. RUGH. December 30th. (Complete.)

28,701. "Improvements in telegraphy." H. O. RUGH. December 30th. (Complete.)

28,723. "Improvements in or connected with the electrical igniting devices of motor cycles." R. H. LINAKER. December 31st.

21,785. "Improvements in elastic supports and connections for incandescent electric lampholders." F. W. PARKINSON. December 31st.

28,748. "Improvements in trolley-wheels or collectors for electric currents." P. T. J. ESTLER and J. L. JACK. December 31st.

28,780. "Improvements in electric furnaces or ovens." A. EIMER. (Date applied for under Patents Act, 1901, May 22nd, 1903, being date of application in United States.) December 31st. (Complete.)

28,782. "Improvements in electric sectional furnaces." A. EIMER. (Date applied for under Patents Act, 1901, May 28th, 1903, being date of application in United States.) December 31st. (Complete.)

28,793. "Improvements in or connected with electrically-operated trains. G. LUDORF. December 31st. (Complete.)

28,794. "Improvements in arc lamps." J. H. WOOLRICH and E. R. SMITH. December 31st.

28,805. "Improvements relating to electric furnaces." C. P. E. SCHNEIDER. December 31st. (Complete.)

28,806. "Improvements in sockets for incandescent electric lamps." C. BAKELEY and J. H. SCHRAGE. December 31st.

28,807. "Improvements in sockets for incandescent electric lamps." C. BAKELEY and J. H. SCHRAGE. December 31st. (Complete.)

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1902.

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CIRCUIT-CLOSING DEVICES FOR THE LINE SELECTORS OF TELEPHONES. O. Graetzer. 11,994. May 26th.

ELECTRICAL TRANSFORMERS. H. H. Lake. (General Electric Co.) 12,078. May 27th.

STAYING TELEGRAPH AND TELEPHONE POLES AND THE LIKE. E. E. Egner and H. C. P. Celion. 12,099. May 27th.

LIGHTNING ARRESTERS. British Thomson-Houston Co., Ltd. (T. J. Johnston.) 18,323. August 20th.

WINDING COILS FOR ELECTRICAL APPARATUS. British Thomson-Houston Co., Ltd. (J. W. Lundskog.) 18,325. August 20th.

PREVENTING CREEPING OF ELECTRIC METERS. British Thomson-Houston Co., Ltd. (A. D. Leint.) 18,329. August 20th.

ELECTRIC HEATER FOR LIQUIDS. F. H. Briggs. 18,420. August 21st.

ELECTRIC FUSES OR CUT-OUTS. H. L. Morse. 18,586. August 23rd.

ELECTRO-MAGNETIC VALVE-CONTROLLING APPARATUS. I. G. Waterman. 20,556. September 20th.

ALTERNATE CURRENT MOTORS. V. A. Fynn. 20,571. September 20th.

ALTERNATE CURRENT MOTORS. V. A. Fynn. 20,572. September 20th.

ELECTRIC STORAGE BATTERIES AND THE LIKE. M. Sutherland and E. Marcuson. 20,871. September 25th.

INCANDESCENT ELECTRIC LAMPS. La Societe Anonyme La Lampe Hollub. 22,827. October 20th.

ELECTRO-PNEUMATIC CONTROLLING SYSTEMS FOR RAILWAY VEHICLES. F. W. Le Fall. (Communicated.) 22,829. October 20th.

ELECTRICALLY IGNITING MINERS' SAFETY LAMPS. R. A. Best and Ackroyd and Best, Ltd. 23,021. October 22nd.

ELECTRICALLY IGNITING MINERS' SAFETY LAMPS. R. A. Best and Ackroyd and Best, Ltd. 23,022. October 22nd.

TUBULAR METALLIC TELEGRAPH POLES. F. G. Guy. 23,047. October 22nd.

ELECTRIC LIGHTING. H. Leitner and R. N. Lucas. 23,066. October 23rd.

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FLEXIBLE METALLIC TUBING FOR ARMOURING INSULATED ELECTRIC CONDUCTORS. W. H. K. Bowley. 23,257. October 24th.

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ELECTRIC ACCUMULATORS. L. Garcin. 23,426. October 27th.

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ARC LAMPS. P. H. F. Spies and C. B. Tutt. 24,122. November 4th.

ELECTRIC CONDUCTING WIRES. W. Peto and T. O. Kent. 24,220. November 5th.

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GENERATION AND APPLICATION OF ELECTRIC CURRENTS FOR ELECTROLYSIS. F. E Elmore. 24,330. November 6th.